Journal of the

Botanical Research Institute of Texas

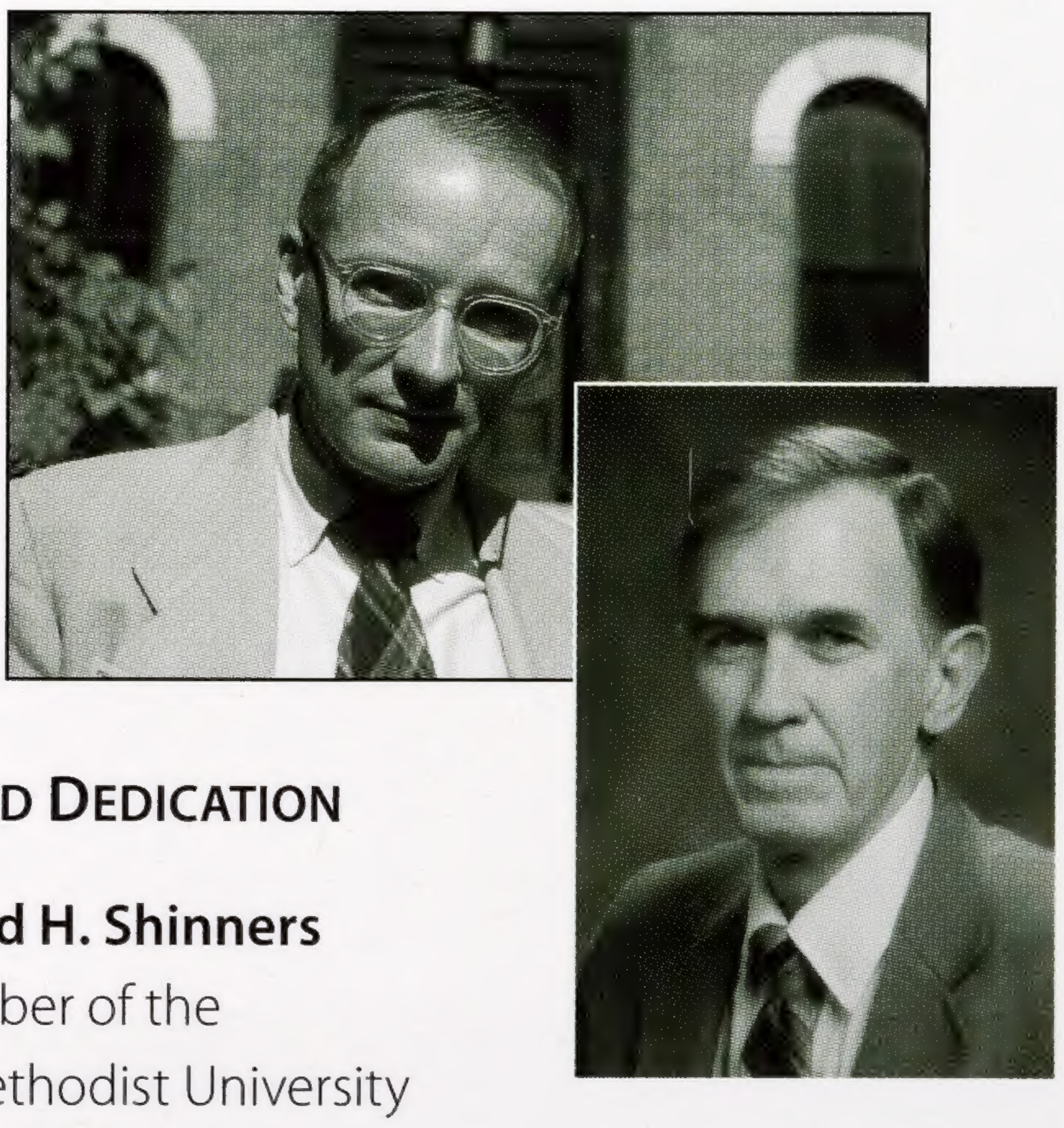
VOLUME 3, NUMBER 2, 25 NOVEMBER 2009

SHOUT
SHARE
IT

JOURNAL OF THE BOTANICAL RESEARCH INSTITUTE OF TEXAS

J. Bot. Res. Inst. Texas ISSN 1934-5259

VOLUME 3 NUMBER 2 25 NOVEMBER 2009



© Hugh H. Iltis

HISTORY AND DEDICATION

1962—Lloyd H. Shinners (left), a member of the Southern Methodist University (SMU) faculty and a prolific researcher and writer, published the first issues of *Sida, Contributions to Botany* (now *J. Bot. Res. Inst. Texas*)

1971—William F. Mahler (right), professor of botany at SMU and director emeritus of BRIT, inherited editorship and copyright.

1993—BRIT becomes publisher/copyright holder.

2007—First issue of J. Bot. Res. Inst. Texas.

MISSION AND GOALS

The BRIT Press seeks innovation and excellence in preparation, manufacture, and distribution of botanical research and scientific discoveries for the twenty-first century.

The BRIT Press—bringing out the best in botanical science for plant conservation and education.

DIRECTION AND COVERAGE

The BRIT Press considers original research papers concerned with classical and modern systematic botany, sensu lato, for publication in *J. Bot. Res. Inst. Texas.* All submissions are peer-reviewed. Guidelines for submissions are available from the BRIT Press website, http://www.britpress.org.

BIBLIOGRAPHICAL

Citation abbreviation for the *Journal of the Botanical Research Institute of Texas* is *J. Bot. Res. Inst. Texas* following the principles of B.P.H. (informally *JBRIT*). International Standard Serial No. (ISSN 1934-5259)

FREQUENCY OF PUBLICATION

J. Bot. Res. Inst. Texas is published semiannually (summer/fall) as one volume by the Botanical Research Institute of Texas.

COPYRIGHT 2009
Botanical Research Institute of Texas (BRIT)
500 East 4th Street
Fort Worth, Texas 76102-4025, USA

EDITOR: Barney Lipscomb
ASSISTANT EDITOR: Brooke Byerley
Botanical Research Institute of Texas
500 East 4th Street
Fort Worth, Texas 76102-4025, USA
817-332-7432; 817-332-4112 fax
Electronic mail: barney@brit.org; jbrit@brit.org

CONTRIBUTING SPANISH EDITOR
Félix Llamas
Dpto. de Botánica, Facultad de Biologia
Universidad de Léon
E-2471 Léon, SPAIN

SUBSCRIPTION PRICES (2010)
$43. Personal (Individual/Family)
$100. USA (Institutional)
$110. Outside USA (Institutional)

SUBSCRIPTIONS/BACK VOLUMES
J. Bot. Res. Inst. Texas and *Sida, Contr. Bot.*
Publications Assistant
Botanical Research Institute of Texas
500 East 4th Street
Fort Worth, Texas 76102-4025, USA
Electronic mail: orders@brit.org

COMPOSITION
rhorngraphics, Plano, Texas; rlrchorn@verizon.net

PRINTING
Prepress production and printing in the United States of America by Millet the Printer, Dallas, Texas
www.millettheprinter.com

COVER ILLUSTRATION
Electronically tinted botanical illustration of *Liatris aestivalis* originally used on BRIT's anniversary poster 2001. Summer gayfeather flowers mid Jul–Aug(–Sep) and is endemic to Oklahoma and Texas. Sida 19:768. 2001. Botanical illustration by Linny Heagy ©2001.

BRIT PRESS

TABLE OF CONTENTS

SYSTEMATICS

Xyris spathifolia (Xyridaceae), a new xyrid from the Ketona Dolomite-Limestone glades of Alabama
ROBERT KRAL AND J. MINCY MOFFETT, JR. 469

Eriogonum cedrorum (Polygonaceae: Eriogonoideae), a new species from northwestern California
JAMES L. REVEAL AND ROGER RAICHE 479

A new narrowly endemic species of **Dirca** (Thymelaeaceae) from Kansas and Arkansas, with a phylogenetic overview and taxonomic synopsis of the genus
AARON J. FLODEN, MARK H. MAYFIELD, AND CAROLYN J. FERGUSON 485

Two new combinations in **Tryphane** (Alsinaceae)
W.A. WEBER AND R.C. WITTMANN 501

Two new species of **Solanum** from Ecuador and new combinations in **Solanum** section **Pachyphylla** (Solanaceae)
STEPHEN R. STERN AND LYNN BOHS 503

Three new species of **Solanum** section **Herpystichum** (Solanaceae) from Ecuador
ERIC J. TEPE AND LYNN BOHS 511

Stenaria sanchezii (Rubiaceae), a new and endangered species from Sonora, Mexico
DAVID H. LORENCE 521

Muhlenbergia tarahumara (Poaceae: Chloridoideae: Cynodonteae: Muhlenbergiinae), a new species from Chihuahua, Mexico
PAUL M. PETERSON AND J. TRAVIS COLUMBUS 527

Una nueva especie y novedades nomenclaturales en el género **Meliosma** (Sabiaceae)
J. FRANCISCO MORALES 535

Estudios en las Apocynaceae neotropicales XXXVII: monografía del género **Rhabdadenia** (Apocynoideae: Echiteae)
J. FRANCISCO MORALES 541

Estudios en las Apocynaceae neotropicales XXXVIII: tres nuevas especies de **Mandevilla** (Apocynoideae: Mesechiteae) para Colombia y Venezuela
J. FRANCISCO MORALES 565

Studies of neotropical Compositae–II. A new combination in **Chromolaena** (Eupatorieae)
JOHN F. PRUSKI 573

Folia taxonomica 13. **Passiflora curva** (Passifloraceae), a new species from French Guiana in subgenus **Passiflora** supersection **Coccinea**
CHRISTIAN FEUILLET 577

Folia taxonomica 14. Notes on **Passiflora** supersection **Coccinea** (Passifloraceae) from the Guiana Shield
CHRISTIAN FEUILLET AND JOHN VANDERPLANK 581

Folia taxonomica 15. Five new species of **Paradrymonia** subgenus **Paradrymonia** (Gesneriaceae: Episcieae) from the Venezuelan Guayana
CHRISTIAN FEUILLET 583

Folia taxonomica 16. **Dilkea** (Passifloraceae) 1. **Epkia,** a new subgenus and five new species from western Amazonia and the Guianas
CHRISTIAN FEUILLET 593

A new species of **Schefflera** (Araliaceae) from the Venezuelan Andes
L.J. DORR AND BASIL STERGIOS 605

New species of **Eugenia** (Myrtaceae) from Ecuador
MARIA LÚCIA KAWASAKI AND BRUCE K. HOLST 609

Revision of **Bauhinia** subgenus **Phanera** section **Schnella** (Cercideae: Caesalpinioideae: Fabaceae)
Richard P. Wunderlin and Richard M. Eilers 619

Revision of **Bauhinia** subgenus **Bauhinia** section **Pauletia** series **Ariaria** (Cercideae: Caesalpinioideae: Fabaceae)
Richard P. Wunderlin 629

Eriogonum villosissimum (Polygonaceae: Eriogonoideae), a new species endemic to Acker Rock, Oregon
James L. Reveal, Dana York, and Richard Helliwell 639

Nomenclatural innovations in **Phlox** (Polemoniaceae), with updated circumscription of **P. caespitosa**, **P. douglasii**, **P. missoulensis**, and **P. richardsonii**
James H. Locklear 645

Validation of the name **Symplocos pentandra** (Symplocaceae)
João Luiz M. Aranha Filho, Peter W. Fritsch, Frank Almeda, and Angela B. Martins 659

Clarifications concerning the nomenclature and taxonomy of **Oxypolis ternata** (Apiaceae)
Mary Ann E. Feist 661

Neotypification of **Artemisia carruthii** (Asteraceae: Anthemideae)
Caleb A. Morse and James L. Reveal 667

A phylogeny of **Arctostaphylos** (Ericaceae) inferred from nuclear ribosomal ITS sequences
Gregory A. Wahlert, V. Thomas Parker, and Michael C. Vasey 673

The reinstatement of **Beautempsia** (Capparaceae) and a key to the genera of neotropical Capparaceae with variously stellate or peltate indumenta
Xavier Cornejo and Hugh H. Iltis 683

Revisión de las especies sudamericanas del género **Schwartzia** (Marcgraviaceae: complejo **Norantea**)
Diego Giraldo-Cañas 691

Again: taxonomy of yellow-flowered caulescent **Oxalis** (Oxalidaceae) in eastern North America
Guy L. Nesom 727

Clarification of the typification of Michaux names in eastern North American **Vitis** (Vitaceae)
Connie Fisk and Alexander Krings 739

Additional morphological measurements of **Arceuthobium siskiyouense** and **A. monticola** (Viscaceae)
Robert L. Mathiasen and Carolyn M. Daugherty 741

Additional observations about **Phaseolus rotundatus** (Fabaceae), an endemic bean species from western Mexico
Jesús Salcedo C., Rogelio Lépiz I., Nora Castañeda A., César Ocampo N., and Daniel G. Debouck 751

BOTANICAL HISTORY

Discovery of a Lewis and Clark grass collection, **Poa secunda** (Poaceae) sensu lato, at the herbarium of the Royal Botanic Gardens, Kew
Jacques Cayouette, James L. Reveal, and Gary E. Moulton 763

FLORISTICS, ECOLOGY, AND CONSERVATION

Pinus pinceana (Pinaceae), nuevo registro para el estado de Nuevo León, México
Susana Favela Lara, Carlos G. Velazco Macías y Glafiro J. Alanís Flores 771

Diversidad y distribución de las gramíneas (Poaceae) en el estado de Zacatecas
Yolanda Herrera Arrieta y Armando Cortés Ortiz 775

Lipocarpha micrantha (Cyperaceae), nueva cita para la flora de Argentina: micromorfología del fruto
Priscila R. Van de Velde y M. Gabriela López 793

Index to Volume 3 (2009)

Titles of Articles with Authors—**998**
Authors—**1001**
Botanical Names and Subjects—**1002**
New Names and Combinations—**1007**

INDEX to new names and new combinations in *J. Bot. Res. Inst. Texas* 3(2), 2009

Appunia longipedunculata (Steyerm.) Delprete, comb. nov.—**809**
Appunia peduncularis (Kunth) Delprete, comb. nov.—**809**
Bauhinia esmeraldasensis Wunderlin, sp. nov.—**631**
Bauhinia lilacina Wunderlin & Eilers, sp. nov.—**621**
Bauhinia trichosepela (L.P. Queiroz) Wunderlin & Eilers, comb. nov.—**627**
Chromolaena clematitis (DC.) Pruski, comb. nov.—**573**
Dilkea cuneata Feuillet, sp. nov.—**595**
Dilkea subg. **Epkia** Feuillet, subg. nov.—**594**
Dilkea lecta Feuillet, sp. nov.—**597**
Dilkea ovalis Feuillet, sp. nov.—**599**
Dilkea tillettii Feuillet, sp. nov.—**599**
Dilkea vanessae Feuillet, sp. nov.—**602**
Dirca decipiens A. Floden, sp. nov.—**494**
Eriogonum cedrorum Reveal & Raiche, sp. nov.—**479**
Eriogonum villosissimum Reveal & D.A. York, sp. nov.—**639**
Eugenia aequatoriensis M.L. Kawasaki & B.K. Holst, sp. nov.—**609**
Eugenia castaneiflora M.L. Kawasaki & B.K. Holst, sp. nov.—**611**
Eugenia crassimarginata M.L. Kawasaki & B.K. Holst, sp. nov.—**611**
Eugenia longisepala M.L. Kawasaki & B.K. Holst, sp. nov.—**614**
Eugenia pusilliflora M.L. Kawasaki & B.K. Holst, sp. nov.—**616**
Mandevilla albifolia J.F. Morales, sp. nov.—**565**
Mandevilla caquetana J.F. Morales, sp. nov.—**567**
Mandevilla sancta-martae J.F. Morales, sp. nov.—**569**
Meliosma isthmensis J.F. Morales, sp. nov.—**537**
Muhlenbergia tarahumara P.M. Peterson & Columbus, sp. nov.—**528**
Paradrymonia glandulosa Feuillet, sp. nov.—**583**
Paradrymonia hamata Feuillet, sp. nov.—**585**
Paradrymonia lutea Feuillet, sp. nov.—**585**
Paradrymonia tepui Feuillet, sp. nov.—**588**
Paradrymonia yatua Feuillet, sp. nov.—**588**
Passiflora curva Feuillet, sp. nov.—**577**
Phlox austromontana subsp. **jonesii** (Wherry) Locklear, comb. et stat. nov.—**645**
Phlox austromontana subsp. **lutescens** (S.L. Welsh) Locklear, comb. et stat. nov.—**646**
Phlox condensata subsp. **covillei** (E.E. Nelson) Locklear, comb. et stat. nov.—**646**
Phlox pilosa subsp. **longipilosa** (Waterf.) Locklear, comb. et stat. nov.—**647**
Phlox richardsonii subsp. **borealis** (Wherry) Locklear, comb. nov.—**647**
Phlox subulata subsp. **setacea** (L.) Locklear, comb. et stat. nov.—**649**
Phlox villosissima subsp. **latisepala** (Wherry) Locklear, comb. nov.—**649**
Schefflera vanderwerffii Dorr & Stergios, sp. nov.—**605**
Solanum circinatum subsp. **ramosum** (Bohs) Bohs, comb. nov.—**509**
Solanum crassinervium Tepe, sp. nov.—**514**
Solanum diversifolium subsp. **chloranthum** (Rusby) Bohs, comb. nov.—**509**
Solanum endopogon subsp. **guianense** (Bohs) Bohs, comb. nov.—**509**
Solanum huilense Bohs, nom. nov.—**509**
Solanum limoncochaense Tepe, sp. nov.—**516**
Solanum manabiense S. Stern, sp. nov.—**504**
Solanum pacificum Tepe, sp. nov.—**512**
Solanum zumbense Bohs, sp. nov.—**506**
Stenaria sanchezii Lorence, sp. nov.—**522**
Symplocos pentandra (Mattos) Occhioni ex Aranha, comb. et stat. nov.—**660**
Tryphane rubella (Wahlenb.) A. & D. Löve ex W.A. Weber, comb. nov.—**501**
Tryphane rubella subsp. **propinqua** (Richardson) A. & D. Love ex W.A. Weber, comb. nov.—**502**
Xyris spathifolia Kral & Moffett, sp. nov.—**472**

XYRIS SPATHIFOLIA (XYRIDACEAE), A NEW XYRID FROM THE KETONA DOLOMITE-LIMESTONE GLADES OF ALABAMA

Robert Kral

Botanical Research Institute of Texas
500 E. 4th Street
Fort Worth, Texas 76102-4025, U.S.A.

J. Mincy Moffett, Jr.

Georgia Department of Natural Resources
Wildlife Resources Division
Nongame Conservation Section
Georgia Natural Heritage Program
2065 U.S. Highway 278 S.E.
Social Circle, Georgia 30025-4743, U.S.A.
Mincy.Moffett@dnr.state.ga.us

ABSTRACT

A distinctive new *Xyris* has been found in a single small (<0.01 ha) calcareous dolomitic (Ketona Limestone) fen in Bibb County, Alabama. The novelty grows alongside the rare and endangered *X. tennesseensis*, but is consistently distinct from it. We distinguish this putative new taxon from the latter, giving it species rank based upon observations of field-collected material, greenhouse common garden trials, and herbarium surveys. The new species, **X. spathifolia** is herein described, figured, and its relationship with *X. tennesseensis* discussed.

RESUMEN

Se ha encontrado un nuevo *Xyris* en un pequeño humedal dolómítico (<0.01 ha) (caliza de Ketona) en el condado de Bibb, Alabama. Esta novedad crece junto con la rara y amenazada *X. tennesseensis*, pero es distinta de ella. Distinguimos esta nuevo taxon putativo, dándole el rango de especie, basándonos en observaciones de material recogido en el campo, pruebas realizadas en invernadero, y revisiones de herbario. Se describe aquí la nueva especie, **X. spathifolia,** se ilustra, y se discute su relación con *X. tennesseensis.*

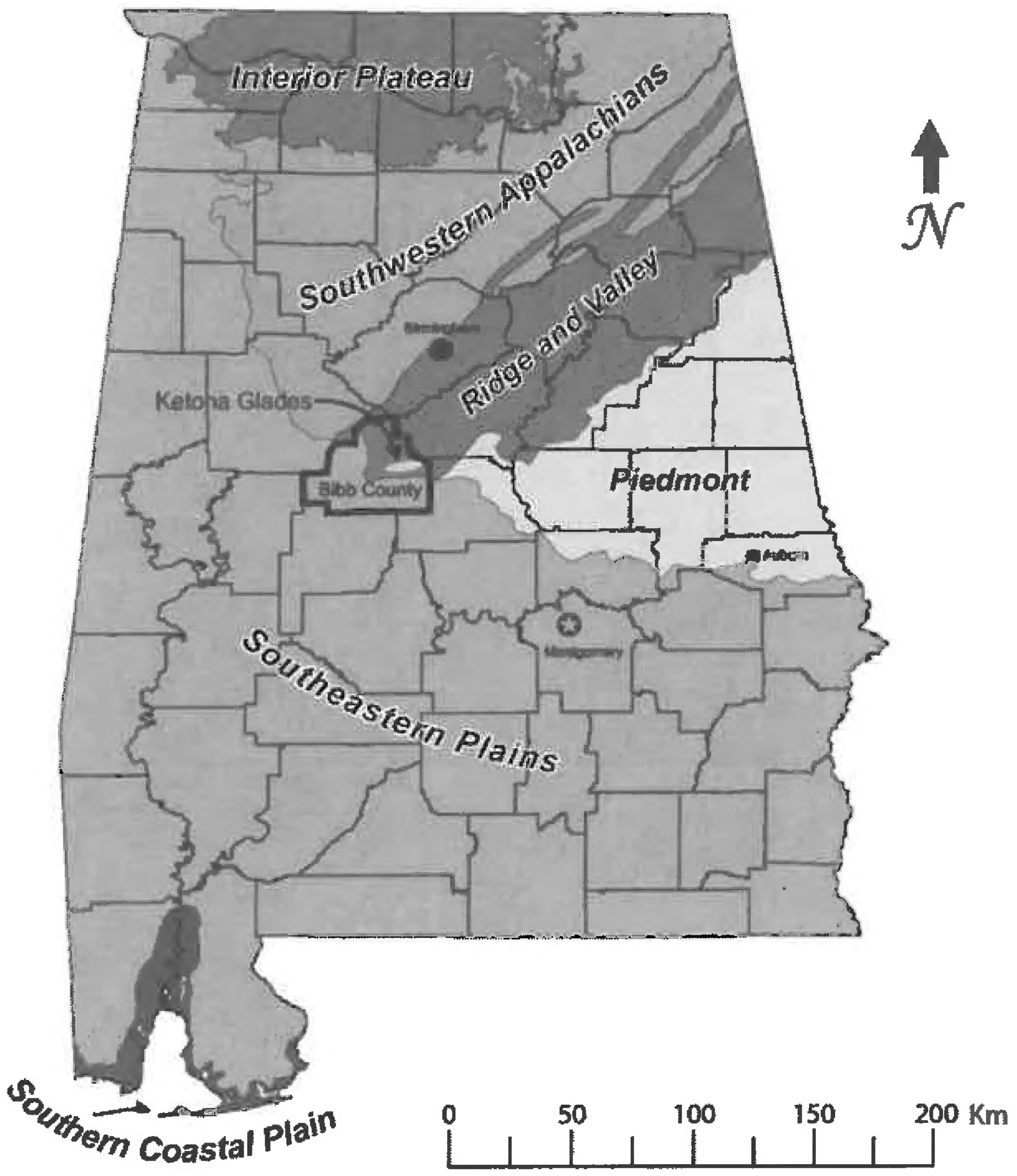
INTRODUCTION

Despite the pervasive notion that cataloging of the vascular plant flora of North America is complete, new species continue to be discovered. Frequently, these discoveries occur in spatial or temporal clusters, revealing a botanical "hot spot," as in the case of the Ketona Glades of Bibb County, Alabama (Ertter 2000), located at the extreme southern edge of the Ridge and Valley Ecoregion (Fig. 1). During the last 10–12 years, nine vascular plant taxa new to science (including the one described herein) have been identified from this area, as well as seven state records including some regional disjuncts, and more than 60 taxa of conservation concern (Allison 2001). With a total flora of over 420 species occurring within an area of ca. 125 ha (Alabama Water Watch 2002), it is one of the most botanically diverse areas in the eastern United States (Allison 2001).

During a 1999 field survey of populations of the rare and endangered *Xyris tennesseensis* Kral in the Ketona Glades, a markedly different xyrid, shorter in stature and smaller in vegetative and floral features, was found admixed with the former in a small, intermittent seep at the headwaters of a tributary to Alligator Creek (*M. Moffett s.n.*, 7 Aug 1999). On the date of the discovery, approximately 900 flowering spikes of the novelty were tallied, emanating from approximately 200 clumps. Individuals of the putative new xyrid showed consistent differences from *X. tennesseensis* across the mixed population. This smaller and different xyrid, thus far known only from the type locality, was once relatively abundant. However, severe drought during the summers of 1999 and 2000 decimated the population. The drastically reduced population size and fluctuating local climate have limited the collection of additional voucher material.

The site of this mixed *Xyris* population, containing the novel xyrid, is a fen/seep complex at the headwaters of Alligator Creek, within an area mapped as "Alligator Glades West" by the Alabama Natural Heritage Program (Alabama Natural Heritage Program 1999), and referred to as "Enchanted Glade" by Allison (2001). Alligator Glades West is one of ca. 45 such sites comprising the Bibb County Ketona Glades and contains the sole known population of this new taxon. The Ketona Glades are shallow-soiled, herbaceous communi-

J. Bot. Res. Inst. Texas 3(2): 469 – 478. 2009



Griffith et al. Ecoregions Level III (1987)

Fig. 1. Map of the study area.

ties atop outcrops of Ketona dolomite, an unusually pure dolomite (i.e., few siliceous contaminants) with relatively high levels of Mg (> 1,100 ppm). The seep itself is very small, ca. 24 m^2 (3 m x 8 m) in size. It is located 1.7 km N of Bulldog Bend (Little Cahaba River) in Bibb County, Alabama (Lat. 33° 04'; Long. 87° 01'). Ownership of this site has changed several times during our investigation. It is currently owned by Forest Investment Associates, and previously by Great Eastern Timber Company, and prior to that by U.S. Alliance/Coosa Pines Corporation, all of whom we are indebted to for access. Extensive searches made along Alligator Creek, and of the six glades (and their ecotones) in Bibb County known to contain *X. tennesseensis*, have yielded no other populations.

METHODS

Common Garden Experiment

The common garden experiment initially developed from an attempt to prevent the extinction of this interesting new taxon. During the severe summer drought of 2000, and following the severe drought in late summer and fall of 1999, there was concern regarding the future viability of this sole known population of *X. spathifolia*. In August 2000, as a hedge against possible future extirpation, a mature fruiting spike was collected from each of the 13 surviving clumps sporting at least two such spikes. A mature fruiting spike also was collected from 13 of the surviving 21 flowering clumps of *X. tennesseensis*. Spikes were stored in separate brown paper sacks in an unheated outdoor shed in Opelika, Lee County, Alabama.

In February 2001, seeds from each spike were sown onto a 60:40 mixture of Pro-Mix (Premier Horticulture, Dorval, Canada) and sand in separate 15.2 cm diameter (6-inch) clay pots and grown in a heated/evaporatively-cooled greenhouse at the Auburn University Plant Science Research Center (PSRC). Approximately 50–100 seeds germinated in each pot by June. Plants were thinned to about 10 per pot during the second year, and their parental identity was carefully maintained. Seedlings removed from pots (and hence the experiment) were grown commingled in flat trays in a separate part of the greenhouse. Annual greenhouse temperatures typically range from ca. 18.3–29.4°C, per PSRC records. During the growing season (March to October), the average daily photosynthetic photon irradiance at bench level (adjusted for 60% shade cloth) ranged from 3 mol m-2 d-1 to 15 mol m-2 d-1, on overcast and sunny days, respectively (Elkins and Wallace 2000). Plants were fertilized every two weeks with liquid 20-20-20 (N-P-K) during the growing season. During the subsequent three years, the seedlings matured and reproduced vegetatively, generating clumps of ca. 30–40 ramets and 30–60 flowering spikes per pot by the summer of 2003.

During the summer of 2004, we realized that what began as a "rescue propagation" could provide data for a limited morphometric analysis of the principal characters distinguishing these syntopic xyrids. The 3-year-old plants of known parentage grown from seed in a common environment constituted a "common garden" experiment. Sample size was N = 25; 12 pots of *X. spathifolia* and 13 pots of *X. tennesseensis*.

The nine morphological characters selected for measurement are aspects of the new taxon that, in the field, appeared most obviously different from *X. tennesseensis*, and were also easily quantifiable. The characters are: leaf length, leaf width, plant height, spike length, lateral sepal length, petal length, anther length, stamen length, and seed length. In all cases, measurements were taken at the widest (or longest) part of a structure along the appropriate axis. With regard to plant height, the longest or "tallest" plant structure for each ramet was measured. This was usually a measure of maximum scape length, although in some cases the structure of greatest length was a leaf. Flower petal length was measured from base of claw to blade apex. Stamens were measured from the point of basal fixation with the anther to the lowest point of basal adnation to the corolla. Seeds were measured along the major axis (i.e., tip to tip). Data were not collected on several other important characters used in North American *Xyris* species classification because of the high similarity of the two taxa for these characters. Excluded characters included: keel features of the lateral sepal, position of the lateral sepal relative to the bracts (i.e., inserted/exserted), color and texture of the leaf sheath, and the presence/absence of a mealy (farinose) seed coating.

Samples were generated by first numbering all reproductive ramets in a pot, and then randomly selecting five ramets from each pot. Sample values for each pot were created by averaging the values recorded from the five randomly selected ramets. Since most of the plants resulting from the original propagation did not flower and produce seeds until summer/fall 2003, it is certain that most ramets selected for measurement in this experiment were the result of asexual, vegetative reproduction. Thus, each sample represented a mean of the progeny of a single distinct, field-identified clump. Samples for different characters were developed using different approaches.

Measurements of leaf length and width were gathered from the four outermost leaves of each selected ramet. Spike lengths were obtained using all spikes from a selected ramet. Measurements of floral structures were recorded from the single open flower on each spike (it is usually the case with *Xyris* that only one flower opens each day per spike). For seed length measurements, all mature capsules were identified on each spike and numbered. One capsule was randomly selected from each spike and then five seeds were subjectively chosen from each capsule for measurement. Plant height measurements involved but a single value for each ramet. Length measurements for petals, sepals, stamens, anthers, and seed length were made using a light microscope with a stage micrometer.

Differences in the nine character means for the two taxa were statistically analyzed using the Student's t-test, except when data violated normality assumptions and were not subsequently improved using either square root or logarithmic transformations. This was the case involving seed size, where the non-parametric Mann-Whitney U-test was employed. Normality was assessed using the Kolmogrov-Smirnov and Wilk-Shapiro tests. Homogeneity of variance assumptions were evaluated using Levene's test, with Levene's correction applied to violations. Effect sizes for t-tests are expressed as eta^2 values, and for the Mann Whitney-U test by an effect size correlation (r $\gamma\lambda$) using Cohen's D. Statistical software utilized was SPSS 16.0. Analysis adhered to procedures found in Pallant (2001) and Shannon and Davenport (2000).

Review of Herbarium Records

Xyris specimens from numerous state, regional, and national herbaria were reviewed and annotated as part of this project. Taxa selected for the review process were either part of the *X. difformis* "complex" (Kral 1978) or known to occur syntopically with *X. tennesseensis*. The *X. difformis* complex comprises *X. difformis* (varieties *curtissii, difformis,* and *floridana*), *X. tennesseensis*, and *X. torta*. *Xyris jupacai* is not considered a member of this complex, but does co-occur with *X. tennesseensis* at a few locations. Only those specimens collected from Alabama, Georgia and Tennessee (the tri-state range of *X. tennesseensis*) were examined. The purpose of this investigation was to determine if specimens of *X. spathifolia* had been collected previously under a different name, thereby providing not only additional specimens for study, but also expanding the known range of the new taxon. Approximately 900 specimens of *X. difformis, X. jupicai, X. tennesseensis*, and *X. torta* were examined from vascular plant collections at AUA, DUKE, GH, JSU (Jacksonville), JSU (Anniston Museum of Natural History), MO, NY, US, TROY, UNAF, HALA, UNA, FLAS, GA, MICH, NCU, TENN, and VDB at BRIT. Herbarium acronyms follow Index Herbariorum (Holmgren 2008).

RESULTS

Common Garden Experiment

Analysis of morphological characters from greenhouse grown plants in a common garden setting revealed significant differences in all nine size-related traits. In all cases, measurements for *X. tennesseensis* specimens were significantly larger than those for *X. spathifolia* (Table 1). Significance values ranged from < 0.001 to 0.03, with effect sizes indicating that 39–93% of the variance in each character was explained by taxon identity. Table 2 provides an assessment of character state differences between the two taxa based on vouchered herbarium specimens and field-collected material.

Review of Herbarium Records

Review of approximately 900 specimens of *X. difformis, X. jupicai, X. tennesseensis* and *X. torta* from 19 national, regional and state herbaria located only a single record fitting the concept of *X. spathifolia,* collected by James R. Allison in 1993 from Alligator Glades West, the sole known extant site of this new taxon.

TAXONOMIC DESCRIPTION

Xyris spathifolia Kral & Moffett, sp. nov. (**Fig. 2**). Type: U.S.A. Alabama. Bibb Co.: Alligator Glades West, small seep over Ketona Dolomite at headwaters of W branch of Alligator Creek (Lat 33° 04'; Long 87°, 01'), 7 Aug 1999, *M. Moffett s.n.* (holotype: VDB).

Xyris spathifolia, Kral et Moffett, sp. nov., *X. tennesseensi* Kral (**Fig. 3**) simillima sed statura breviora 15–40 (non 30–70 cm) alta, laminis vaginibusque foliorum valde (non leviter) papillosis, scapis apicem versus valde 5–7-costatis (non bicostatis), caulis basi rhizomatibus brevis ascendentibus muntis (non erhizomatibus), differ.

Perennial, cespitose, 15–40(–50) cm tall, roots fibrous. Stems short, or present as slender, ascending, rhizome-like bases on innovations (result of burying of clump by seciment). Leaves ascending to erect, 15–30 cm long, soft, sheaths often fully as long as blade or longer, gradually widening from keeled apex to convex base, proximally multi-costate, smooth, pale tan to brown, upsheath with tints of red or pink, progressively increasingly papillose, densely so and green distally, margins pale, scarious, gradually narrowed to blade (this often most of its length infolding distal leaf of innovation); blade linear, mostly 1–2 mm wide, slightly to very twisted, flattened, margins proximally to medially strongly papillose, toward apex smooth or nearly so; apex narrowed, excentrically acute, its incurved tip incrassate, blunt, smooth; surfaces densely pale-granular-papillose and interruptedly rugulose proximally, progressively smoother up-blade. Scape sheaths shorter than principal leaves, mostly open, short-bladed. Scapes erect or ascending, narrowly linear, ca. 1 mm thick, twisted, pale green, proximally subterete with (mostly) 5–8 papillate costae, the intervals smooth or nearly so, distally sharply unequally angulate-ribbed, with up to 5(–7) costae making the angles, 2–3 most raised, all densely papillate-tuberculate, the intervals sulcate to broadly concave, slightly to very papillose or papillose-rugulose in short lines. Spikes ovoid to ellipsoidal or lance-ovoid, 5–8 mm long, blunt, several flowered, bracts in flat spiral, loosely imbricate, the proximal 2–3 sterile, narrowly ovate-triangular, 2.5–3 mm

TABLE 1. Comparison (mean ± SE) of nine different character states evaluated in the common garden experiment. Independent samples t-tests were used for the first eight characters. The Mann-Whitney U test was used for the ninth character (seed size). Homogeneity of variance violations and subsequent Levene's corrections are indicated by asterisks (*). Degrees-of-freedom values departing from 23 ($N_1 + N_2 - 2$) result from these corrections. A significance threshold of $\alpha = 0.05$ was used. Effect sizes for t-tests and Mann-Whitney U tests are given by eta² and effect size correlation ($r\,\gamma\lambda$) using Cohen's D, respectively.

Character	***X. spathifolia*** (***n*** = 12) (mean ± S.E.)	***X. tennesseensis*** (***n*** = 13) (mean ± S.E.)	d.f.	Test Statistic	Sig.	Effect Size
Leaf length (cm)	24.1 ± 1.57	48.9 ± 2.3	20.8	-8.87 *	<0.001	0.774
Leaf width (mm)	1.51 ± 0.16	6.98 ± 0.69	13.3	-7.77 *	<0.001	0.733
Plant height (cm)	27.5 ± 3.54	48.6 ± 3.83	23	-4.05	0.001	0.413
Spike length (mm)	6.75 ± 0.42	13.0 ± 0.67	19.8	-7.93 *	<0.001	0.732
Petal length (mm)	3.46 ± 0.03	4.44 ± 0.04	22.2	-17.5 *	<0.001	0.930
Sepal length (mm)	4.27 ± 0.06	4.77 ± 0.07	23	-5.59	<0.001	0.575
Stamen length (mm)	1.01 ± 0.02	2.14 ± 0.06	15.7	-17.1 *	<0.001	0.926
Anther length (mm)	0.55 ± 0.02	1.74 ± 0.07	13.8	-17.1 *	<0.001	0.927
Seed length (mm)	0.52 ± 0.01	0.55 ± 0.01	22.7	-2.18	0.03	0.39

TABLE 2. Comparison of selected morphological features in two *Xyris* taxa.

Character State	***Xyris spathifolia***	***Xyris tennesseensis***
Plant height	15–40(–50) cm	30–70(–85) cm
Stem base	May be short-ascending-rhizomatous (ascending lateral offshoots)	Lacks rhizomes
Principal leaves (length × width)	15–30 cm × 1–2 mm	40–60 cm × 4–10 mm
Leaf surfaces	Sheath papillate medially and distally, blade edges papillate, proximal surfaces papillate	Sheath smooth or finely papillate, sheath keel sometimes papillate, blade edges mostly smooth, surfaces smooth
Scapes	Subterete and multicostate proximally, ca. 1 mm wide distally, sharply 5–7 angled isodiametric, ridges densely papillate-tuberculate, some sharply raised, intervals sulcate or deeply concave, papillate	Subterete and multicostate proximally, 2–3 mm wide distally, often compressed, 3–5 ridged, with 2 ridges flattened and wing-like, all papillate at edges, intervals smooth, level to shallowly concave
Spikes	Ovoid to ellipsoidal or lanceovoid, 5–8 mm	Ovoid, 10–15 mm
Lateral sepals	4.0–4.5 mm long, lanciform, keel ascending-lacerate apically	4.5–5.0 mm long, lanciform, keel ascending-lacerate apically
Petal blades	Obovate, ca. 3.5 mm	Obovate, ca. 4.5 mm
Stamens	1–1.1 mm long, anthers 0.5–0.6 mm	2–2.4 mm long, anthers 1.5–2 mm
Seeds	Ellipsoidal, ca. 0.5 mm, slightly farinose slightly to very farinose	Ovoid to broadly ellipsoidal, ca. 0.5–0.6 mm,

long, keeled, the fertile ones broadly obovate, 4.5–5 mm long, convex, apex broadly rounded, entire, aging erose, surface a lustrous rich brown with a green, ovate, subapical, granular dorsal area. Lateral sepals free, equilateral, oblanceolate (viewed from side), ca. 4–4.5 mm long, acute, the thin keel entire proximally, progressively widening and shallowly ascending-lacerate distally. Petals distinct, blades obovate (measured from claw apex), ca. 3.5 mm long, apically erose; staminodia bibrachiate, staminodial hairs pencillate, slightly clavate. Capsule ellipsoid-cylindric, 2–2.5 mm long, placentation 3-parietal; seeds broadly ellipsoid to narrowly ovoid, ca. 0.5 mm long, apiculate, with 8–10 ribs/side, slightly farinose.

Etymology.—The epithet "*spathifolia*" is based on a peculiar morphology of lower leaves of innovations. These are spathe-like, their margins conduplicate and enfolding inner leaves.

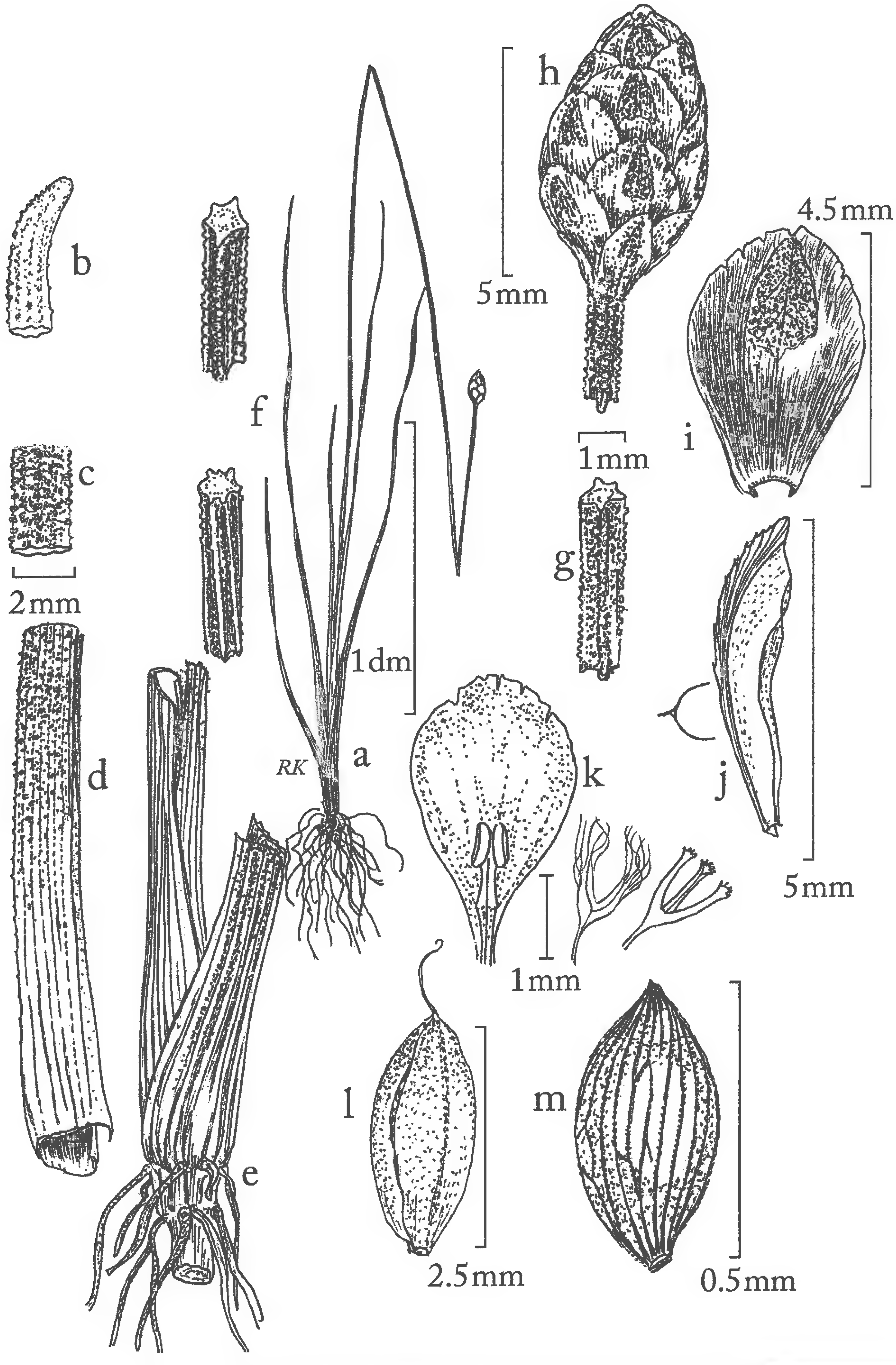

h
5mm
b
4.5mm
f
1mm
i
c
2mm
g
1dm
d
RK
a
k
j
5mm
1mm
l
m
e
2.5mm
0.5mm

Fig. 2. *Xyris spathifolia* (from the type). **a.** Habitat sketch. **b.** Leaf tip. **c.** Sector of leaf midblade. **d.** Leaf sheath. **e.** Base of innovation. **f.** Sectors of lower (below) and middle (above) scape. **g.** Sector of distal part of of scape. **h.** Spike. **i.** Fertile bract. **j.** Lateral sepal. **k.** Petal blade and anther (left), staminodium and style branches (right). **l.** Capsule. **m.** Seed.

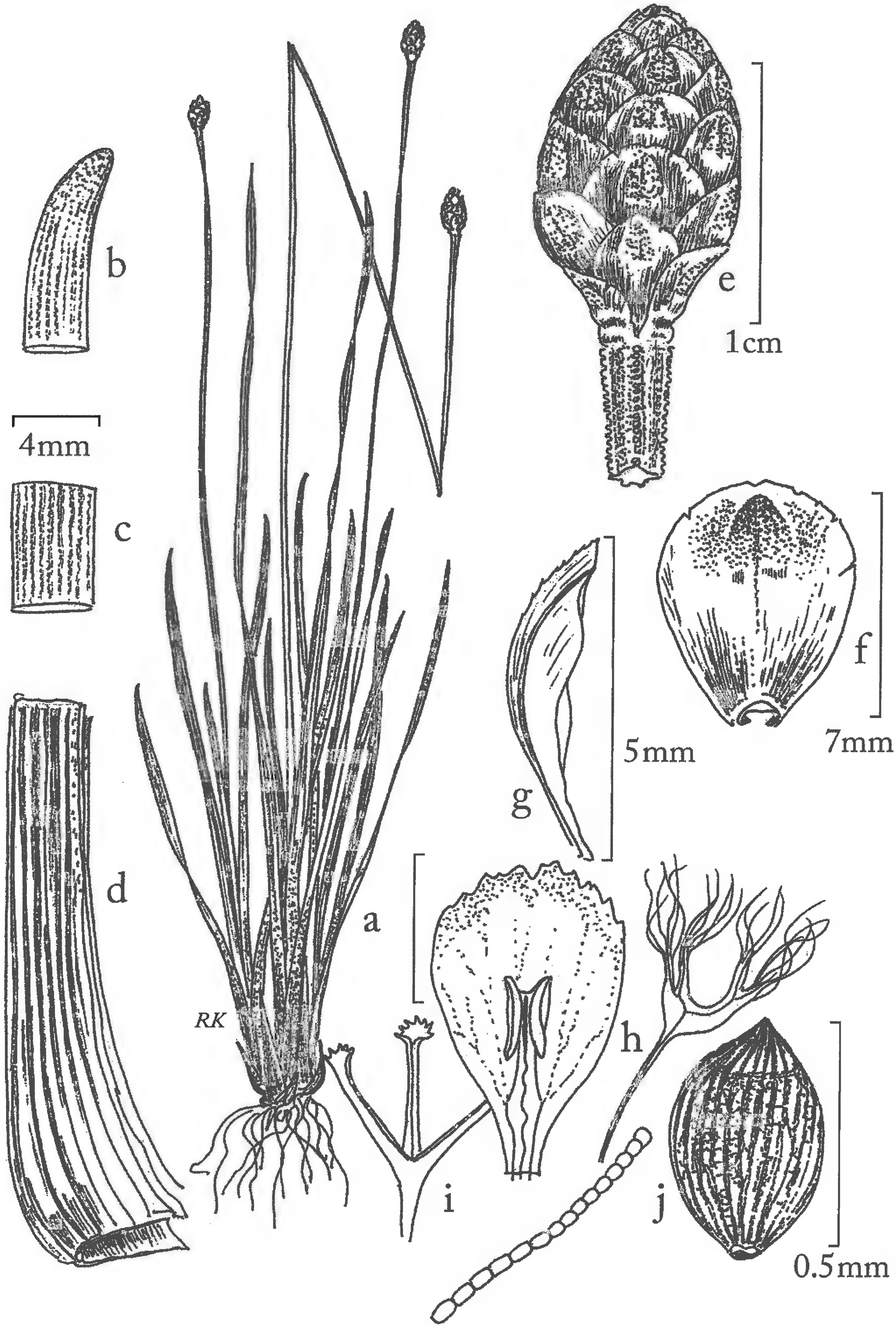


Fig. 3. *Xyris tennesseensis* (from *A. Schotz & L. Wyckoff 1546*). **a.** Habit sketch. **b.** Leaf tip. **c.** Sector of leaf midblade. **d.** Leaf sheath. **e.** Spike. **f.** Fertile bract. **g.** Lateral sepal. **h.** Petal blade, stamen (left); staminodium, enlarged view of beard hair (right). **i.** Stylar apex. **j.** Seed.

PARATYPE: ALABAMA. Bibb Co.: Alligator Glades West, small seep over Ketona Dolomite at headwaters of W branch of Alligator Creek (Lat 33° 04'; Long 87°, 01'), 7 Aug 1999, *R. Kral & M. Moffett 90103* (VDB).

Other specimens examined: ALABAMA. Bibb Co.: Alligator Glades West, small seep over Ketona Dolomite at headwaters of W branch of Alligator Creek (Lat 33° 04'; Long 87°, 01'), 5 Sep 1993, *James R. Allison* 7963 (AUA).

KEY TO *XYRIS TENNESSEENSIS* SYMPATRIC XYRIDS, INCL. *XYRIS DIFFORMIS* COMPLEX

1. Keel of laeral sepals usually firm, papilate, ciliate, ciliolate, or fimbriate, or in various combinations of these ____ **Xyris torta**
1. Keel of lateral sepals scarious, lacerate to (rarely) nearly entire.
  2. Leaf sheaths or sheath base light green, straw-colored, or dull brown ____ **Xyris jupicai**
  2. Leaf sheaths or sheath base with red, pink, or purple tints, or glossy brown or red-brown.
    3. Seeds opaque or mealy.
      4. Base of mature plant bulbous.
        5. Plant 30–70 cm in height; leaf sheaths and blade surfaces mostly smooth or just slightly papillate along keels and edges; scapes with 2 ridges somewhat flattened and wing-like distally, all papillate at edges; stem base lacks rhizomes ____ **Xyris tennesseensis**
        5. Plant 15–40 cm; leaf sheaths and blade surfaces papillate; scapes sharply 5–7 angled distally, ridges densely papillate-tuberculate; stem base possesses what may be short ascending rhizomes ____ **Xyris spathifolia**
      4. Base of mature plant not bulbous ____ **Xyris difformis** var. **floridana**
    3. Seeds translucent.
      6. Leaves and scapes (except for edges and ribs) smooth; scape somewhat to much widened distally; 2 ribs comparably wider, making wings smooth or papillate ____ **Xyris difformis** var. **difformis**
      6. Leaves and scapes variously papillate or minutely scabrous; scapes not much widened distally; ribs all equally prominent, somewhat scabrous ____ **Xyris difformis** var. **curtissii**

DISCUSSION

As mentioned in the prefatory paragraph, this plant, thus far known only from the type locality, was once abundant (over 200 clumps on the lower side of a small open seep). However, on our return to the site in August 2000, severe drought had drastically reduced numbers (thus eliminating the chance for additional voucher material). We hope to provide more vouchers once the population has recovered.

The question of what rank to assign this novelty is intriguing. Certainly, careful attention should be given to the plant at its sole known location, as well as searching for it in other calcareous fens of the area. Of particular interest is the fact that, prior to this discovery, only *Xyris tennesseensis* of North American xyrids was known to occupy fen-like habitats. One would be tempted to consider the new morphology a simple anomaly, perhaps a reaction to extreme habitat by *X. tennesseensis,* were it not for the side-by-side mixing of the two, which, nonetheless, are easily distinguished on the basis of several characters.

Differences in several character states between *X. spathifolia* and *X. tennesseensis* were manifest primarily in terms of leaf and scape surface features (i.e., ridges, wings, papillae), and the size of individual characters, as well as the overall plant. There was also a tendency for some *X. spathifolia* specimens to possess small lateral ascending offshoots reminiscent of rudimentary rhizomes, a feature not known from other North American xyrids. The differences exhibited by the new taxon are of a nature and degree that are consistent with species status distinctions recognized for this genus (Kral 1966; Kral 2000).

CONSERVATION CONSIDERATIONS

Considering the documented rarity of *X. spathifolia*, its association with and similarity to *X. tennesseensis*, and the specific threats associated with its single known extant site, a strong argument can be made for a "high" conservation ranking. This sole isolated site is located within a fire-suppressed loblolly pine plantation with severe woody tree/shrub encroachment. The overstocked plantings along (and within) the intermittent stream course supplying the fen are capable of drastically reducing groundwater levels (Jackson et al. 2005). Moreover, this site lacks formal legal protection (i.e., it is privately owned with no conservation easements/covenants in place). Thus it would seem to satisfy the requirements of both extreme rarity and threat necessary to justify a critically imperiled ranking both globally and in Alabama (G1/S1), using the NatureServe (2008) system.

The rarity and threat to *X. spathifolia* would support its status as the xyrid of greatest conservation concern in North America (north of Mexico). The currently recognized *Xyris* species of greatest conservation concern is *X. tennesseensis*, known from approximately 25 sites in three states (AL, GA, and TN) with a NatureServe global ranking of imperiled (G2). *Xyris tennessensis* also has status and receives protection under the federal Endangered Species Act of 1973, under state law in Georgia through the Georgia Wildflower Preservation Act of 1973 (Georgia Dept. of Natural Resources 2008), and under state law in Tennessee through the Rare Plant Protection and Conservation Act of 1985 (Crabtree 2008). Conversely, as *X. spathifolia* is only now being recognized as a new species, it enjoys no legal protections at either the federal or state level. Further contributing to this precarious situation is the lack of any state laws protecting rare plants in Alabama.

The conservation situation involving *X. spathifolia* is obviously dire. Currently, there is some living material remaining from the common garden study that will be safeguarded at Georgia Plant Conservation Alliance (GPCA) member institutions and the Auburn University Donald E. Davis Arboretum. Visits to obtain additional *X. spathifolia* seed from the Alligator Glades West site, in order to bolster the existing *ex situ* collections, will be made in August/September of this year (2009). Efforts will also be made to work cooperatively with the new property owners of the Alligator Glades West site, Forest Investment Associates, to better manage the site for the benefit of both xyrids.

ACKNOWLEDGMENTS

The authors wish to express their gratitude to the U.S. Alliance/Coosa Pines Corporation, and the Great Eastern Timber Company for their access to the site, and to Jim Allison, Georgia Department of Natural Resources, Natural Heritage Program, for his 1998 tour of all known Bibb County Glade sites containing *X. tennesseensis*, including the site for this research. Two anonymous reviewers provided constructive and helpful reviews. We also wish to acknowledge Curtis Hansen, Curator, John D. Freeman Herbarium, for his assistance with loan material.

REFERENCES

Alabama Natural Heritage Program. 1999. Element occurrence records: *Xyris tennesseensis*. The Nature Conservancy, Montgomery, AL.

Alabama Water Watch. 2002. Citizen guide to Alabama rivers (volume 1): Black Warrior and Cahaba. Alabama Water Watch website, an on-line report series. http://www.alabamawaterwatch.org/awwp/publications/report_series/cahwar/war-cah.pdf (Accessed 11/3/04).

Allison, J.R. and T.E. Stevens. 2001. Vascular flora of the Ketona dolomite outcrops in Bibb County, Alabama. Castanea 66:154–205.

Crabtree, T. 2008. Tennessee Natural Heritage Program: rare plant list. Tennessee Department of Environment and Conservation, Division of Natural Areas. Updated January 2008. http://www.state.tn.us/environment/na/pdf/plant_list.pdf. (Accessed: May 10, 2008).

Elkins, C. and B. Wallace. 2000. PPFD and PAR data for PSRC greenhouse complex. Unpublished data, Plant Sciences Research Center, Auburn University, AL.

Ertter, B. 2000. Floristic surprises in North America North of Mexico. Ann. Missouri Bot. Gard. 87:81–109.

Georgia Department of Natural Resources. 2008. Wildlife Resources Division: Georgia rare species and natural community information. ‹http://georgiawildlife.org/rareorendangeredspecies_conservation.aspx› (Accessed: July 17, 2008).

Holmgren, P.K. and N.H. Holmgren. 1998 [continuously updated]. Index Herbariorum: a global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. http://sweetgum.nybg.org/ih/. (Accessed May 10, 2008).

Jackson, R.B., E.J. Jobbágy, R. Avissar, S.B. Roy, D.J. Barrett, C.W. Cook, K.A. Farley, D.C. leMaitre, B.A. McCarl, and B.C. Murray. 2005. Trading water for carbon with biological carbon sequestration. Science 310:944–1947.

Kral, R. 1966. The genus *Xyris* (Xyridaceae) in the southeastern United States and Canada. Sida 2:177–260.

Kral, R. 2000. *Xyris*. In: Flora of North America Editorial Committee, eds. 1993+. Flora of North America north of Mexico. 12+ vols. New York and Oxford. 22:154–167.

NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, VA. http://www.natureserve.org/explorer. (Accessed: May 8, 2008).

Pallant, J. 2001. SPSS survival manual. Open University Press, Buckingham, GreatBritain.

Shannon, D. and M. Davenport. 2001. Using SPSS to solve statistical problems. Prentice Hall Inc., Upper Saddle River, NJ.

ERIOGONUM CEDRORUM (POLYGONACEAE: ERIOGONOIDEAE), A NEW SPECIES FROM NORTHWESTERN CALIFORNIA

James L. Reveal
L.H. Bailey Hortorium Herbarium
Department of Plant Biology
Cornell University
412 Mann Library
Ithaca, New York 14853, U.S.A.
jlr326@cornell.edu

Roger Raiche
Planet Horticulture Garden Design
3485 Old Lawley Toll Road
Calistoga, California 94515, U.S.A.
roger@planethorticulture.com

ABSTRACT

Eriogonum cedrorum of the subg. *Oligogonum* is proposed and illustrated for a localized endemic confined to The Cedars area of Sonoma Co., California. The new species, allied to *E. nervulosum,* differs from that species in having bright yellow flowers that are on shorter stipes but associated with longer involucres.

RESUMEN

Se propone y se ilustra **Eriogonum cedrorum** del subg. *Oligogonum* para un endemismo confinado al área de The Cedars del condado de Sonoma, California. La nueva especie, emparentada con *E. nervulosum,* difiere de esta última por tener flores amarillo brillante que están en estipes más cortas pero asociadas con involucros más largos.

The Cedars wild buckwheat, *Eriogonum cedrorum*, has been known to botanists since first collected by Freedom W. Hoffman (1880–1959) in 1947. In the mid 1980s Raiche made additional collections, which Reveal mistakenly assigned to *E. nervulosum* (S. Stokes) Reveal, leading to confusion in the description of that species (e.g., Reveal 2005). An opportunity to study the two species in the field in late July of 2009 showed that the two were not the same and The Cedars plant is now described formally.

Eriogonum cedrorum Reveal & Raiche, sp. nov. (**Figs. 1–2**). Type: UNITED STATES. California: Sonoma Co.: The Cedars, Central Canyon area NE of Layton Mine and S of the "upper mine" on steep, gravelly, serpentine, N-facing slopes at 410 m elev., 38°37'16"N, 123°07'37"W, T9N, R12W, sec. 13SENE, 28 Jul 2009, *J.L. Reveal & R. Raiche 8989* (holotype: NY; isotypes: BH, BM, BRY, CAS, GH, LL, MO, OSC, RM, RSA, TEX, UC, US, UTC).

A *Eriogono nervuloso* floribus flavis (nec albis), involucres longioribus (4–6.5 mm nec 3–4 mm) et stipitibus brevioribus (0.1–0.3 mm nec 0.5–0.8 mm) differt.

Plants low spreading synoecious herbaceous perennials, 1–4(–10) dm long, 1–3(–5) dm across, composed of loosely arranged rosettes of tufted leaves at tips of slender, woody caudex branches arising from a stout woody taproot. **Leaves** tightly arranged in small, more or less well defined basal rosettes; petiole 0.3–0.8(–1.1) cm long, densely tannish-white tomentose, arising from a narrowly elongate triangular petiole base, 2–3.5 mm long, 1.5–2 mm wide, tomentose and minutely villous abaxially, glabrous and tannish adaxially; blade broadly elliptic to ovate, 0.7–1.5 cm long, 0.4–1 cm wide, tannish-white lanate abaxially, thinly tomentose to glabrate or glabrous and greenish to light olive-green adaxially especially with age, with a broadly obtuse to rounded base not tapering to the petiole, an entire, plane margin, and a mostly obtuse to broadly obtuse apex; midvein slightly raised, obscured by tomentum. **Aerial flowering stems** erect to slightly spreading, 2–8 cm long, villous, bractless. **Inflorescences** compound umbellate, slightly open, mostly 1–2 cm long, 1–3 cm across; branches villous, grayish to greenish white, not drying blackish; bracts 4–6 at base of inflorescence, spreading, sessile or nearly so with elliptic blades, 4–10 mm long, (1.5–)2–4 mm wide, usually white tomentose abaxially, thinly tomentose and slightly greenish adaxially; centrally positioned peduncle 5–10 mm long, villous; lateral branches 3–8 mm long, these terminated by a whorl of 4–6 linear to narrowly oblanceolate bracts, 2–8 mm long, 0.7–1.2 mm wide; peduncles atop lateral branches 2–5(–7)

J. Bot. Res. Inst. Texas 3(2): 479 – 483. 2009

mm long, villous. **Involucres** solitary, broadly turbinate, 4–6.5 mm long, 3.5–5.5(–6) mm wide, densely villous abaxially, glabrous adaxially; teeth 6–8, erect, acute (when long) to obtuse or even rounded apically, 0.3–0.6(–1) mm long **Pedicels** erect to slightly curved with age, 4–6.5 mm long, glabrous; bractlets linear, 4–6(–6.5) mm long, densely villous. **Flowers** bright yellow at early anthesis, rapidly becoming fused with red and ultimately red to reddish maroon with an undertone of yellow, 2–3 mm long when yellow becoming 4.5–6 mm at maturity on a 0.1–0.3 mm long stipe, glabrous; tepals monomorphic, obovate; stamens slightly exserted, with 2–4 mm long, slightly pilose basally filaments, and oval, yellow, 0.4–0.6 mm long anthers; pistil with styles 1–1.3(–1.5) mm long. **Achenes** light yellowish brown, narrowly trigonous, 4.5–6 mm long, glabrous; embryo straight.

Distribution.—Known only from serpentine talus slopes and rock crevices at The Cedars, 1200–1800 ft elev, Sonoma Co., California (Fig. 3). Jun–Sep.

Additional collections examined: **U.S.A. CALIFORNIA. Sonoma Co.:** Layton Mine, Austin Creek, 29 Sep 1947, *Hoffman 507* (CAS, RSA, UC, UTC); on King Ridge Road near Red Slide, E of Austin Creek, The Cedars, 550 m elev., 23 Jun 1984, *Raiche 43234* (CAS); near Layton Mine N of Cazadero, The Cedars, 370 m elev., 10 Aug 1985, *Raiche 50716* (CAS).

Eriogonum cedrorum (from the Latin *cedrorus*, of cedars) is a member of subg. *Oligogonum* Nutt., a taxon typified by *E. umbellatum* Torr., that presently is composed of some 35 species of subshrubs and herbaceous perennials that occur from Alaska to central Mexico, and from Virginia and West Virginia to the Pacific Coast. The new species belongs to a subgroup characterized by an involucre with erect teeth and smallish leaves arranged into rosettes that result is low, spreading mats. Therefore, within the subfamily The Cedars wild buckwheat may be quickly distinguished by a whorl of bracts immediately below the inflorescence, glabrous flowers on short stipes that are initially yellow but rapidly change to a red or reddish-maroon, a synoecious habit, villous involucres, and leaf-blades that are lanate abaxially. Based on the yellow flower color, *E. cedrorum* is allied to *E. ternatum*, but that species differs in its compact mat of densely arranged rosettes of leaves terminated by long (10–30 cm long) flowering stems that bear an umbellate inflorescence with sulphur-yellow flowers that remain distinctly yellow even at maturity. *Eriogonum cedrorum* differs from the more closely allied *E. nervulosum* of nearby Colusa, Glenn, and Lake counties, California, by its yellow (not white) flowers, and while both quickly become reddish, the yellow and white undertone is retained in each species. Both of these species occur on serpentine but *E. nervulosum* tends to be more compact than *E. cedrorum*. Both species have relatively short aerial flowering stems and similar leaves, but they differ in lengths of their involucres (4–6.5 mm in *E. cedrorum* versus 3–4 mm in *E. nervulosum*) and in the length of their stipes (0.1–0.3 mm versus 0.5–0.8 mm, respectively). Also individual plants of *E. cedrorum* tend be larger than those of *E. nervulosum*, but this may be the result of the loose talus slopes where *E. cedrorum* is found rather than any significant genetically-fixed morphological difference. Both species differ from *E. ternatum* in having compound umbellate inflorescences (Fig. 2), with that of *E. cedrorum* more open (and thus more obviously branched) than that of *E. nervulosum*, which often appears to be subumbellate.

The Cedars wild buckwheat joins a small number of other relatively restricted species found within the more or less 7000 acres that defines The Cedars. This area is an isolated block of ultramafic mantle rock (Harzburgite), and its derived soils, which is only nine air miles from the moist, fog-dominated coastal climate influenced by the Pacific Ocean; nonetheless, the area is dominated by a hot dry summer more typical of the interior California climates well to the east. Six other plant species are endemic here: *Arctostaphylos bakeri* Eastw. ssp. *sublaevis* P.V. Wells, *Calochortus raichei* Farwig & Girard, *Epipactis gigantea* Douglas ex Hook. f. *rubrifolia* P.M. Br., *Erigeron serpentinus* G.L. Nesom, *Streptanthus glandulosus* Hook. ssp. *hoffmanii* (Kruckeb.) M. Mayer & D.W. Taylor, and *S. morrisonii* F.W. Hoffm. ssp. *hirtiflorus* F.W. Hoffm. In addition we are aware of an undescribed *Holodiscus* taxon.

While The Cedars terrain is dominated by Sargent cypress woodland (*Hesperocyparis sargentii* (Jeps.) Bartel) and chaparral, the extremely steep canyon slopes are mostly open rock and talus forming extensive serpentine barrens. This open rock and talus is the only place that *Eriogonum cedrorum* grows, and only a small portion of this habitat seems suitable for this wild buckwheat. The majority of plants grow in loose gravelly

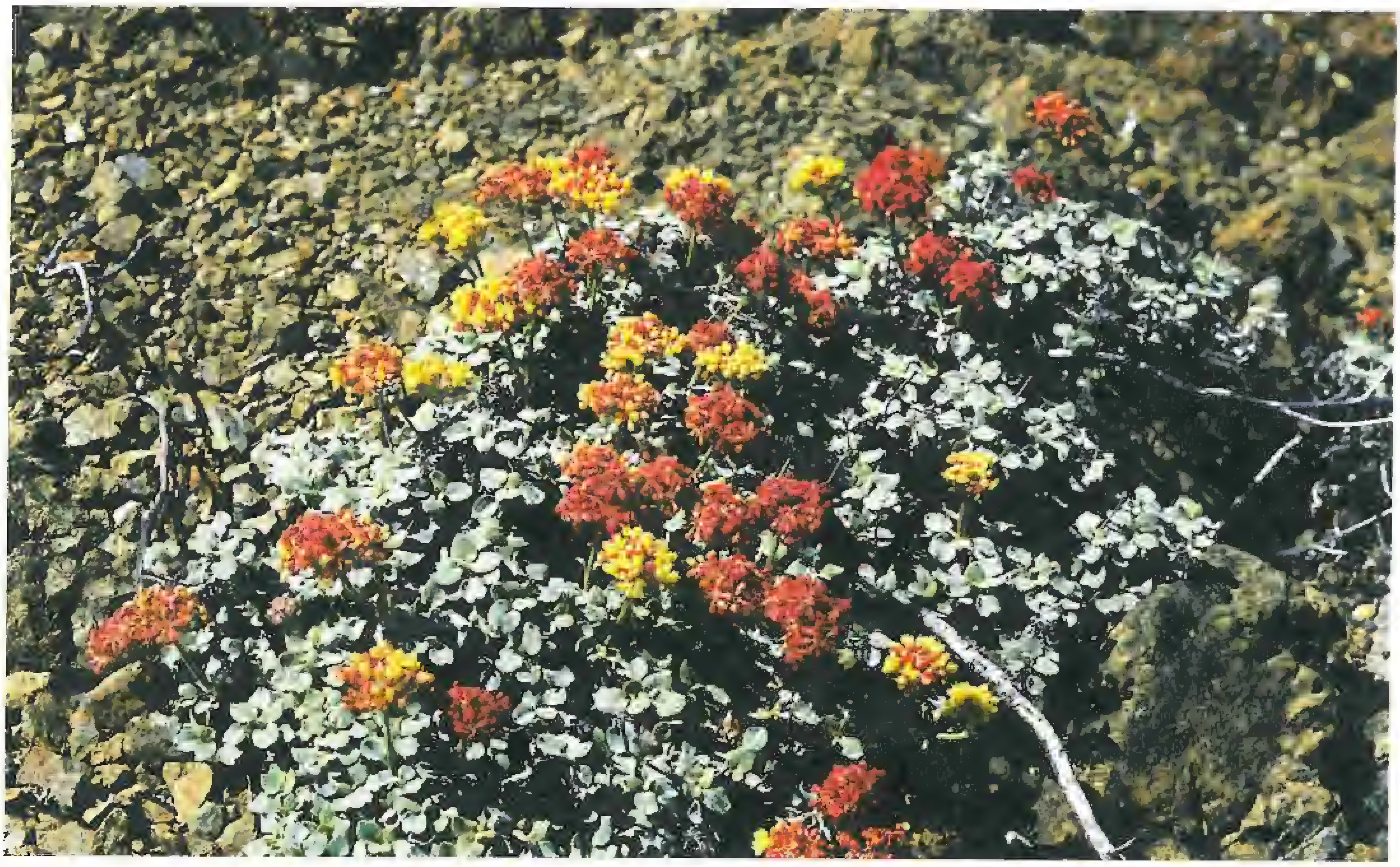


Fig. 1. *Eriogonum cedrorum*, habit.

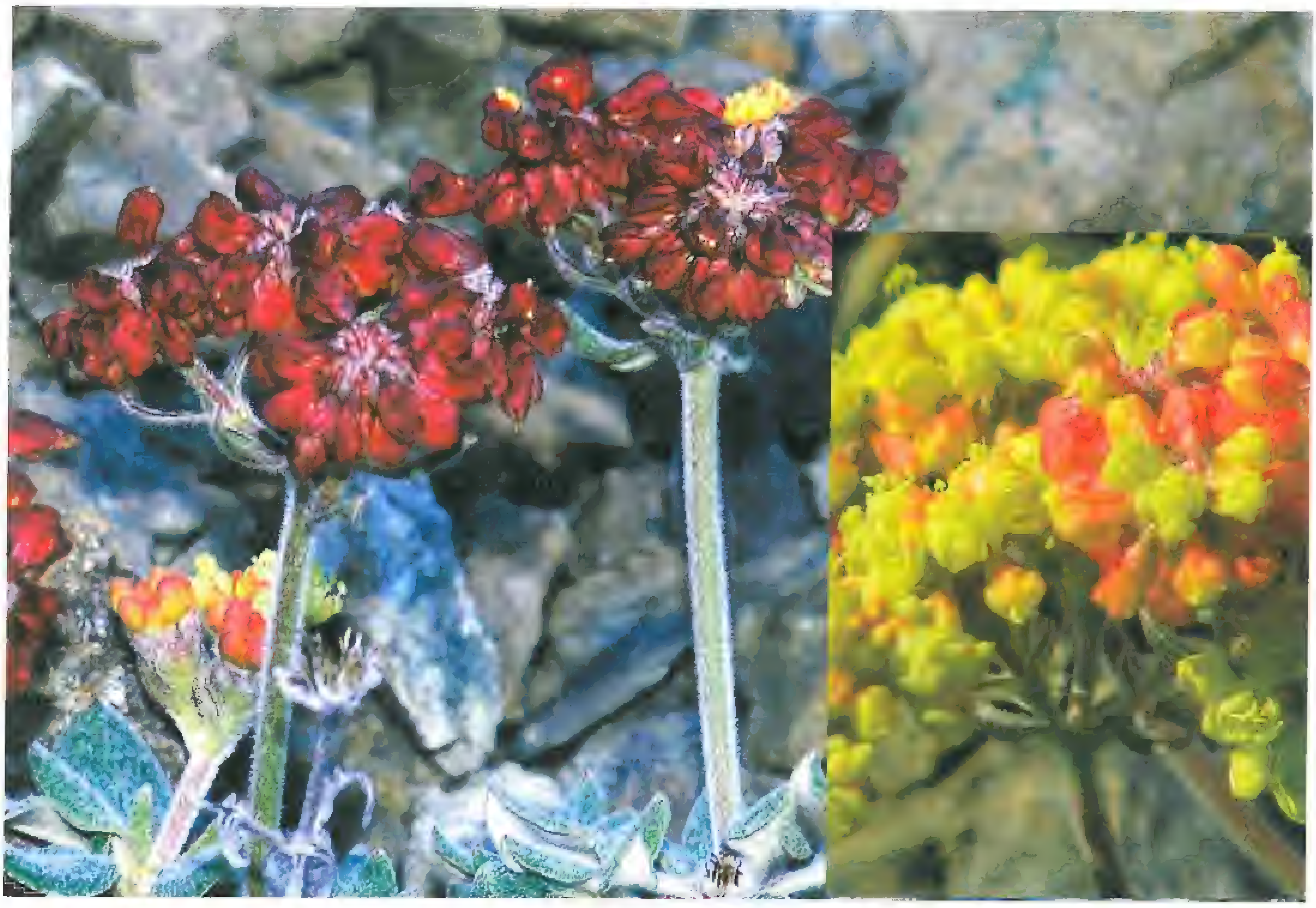


Fig. 2. *Eriogonum cedrorum*, details of inflorescences.

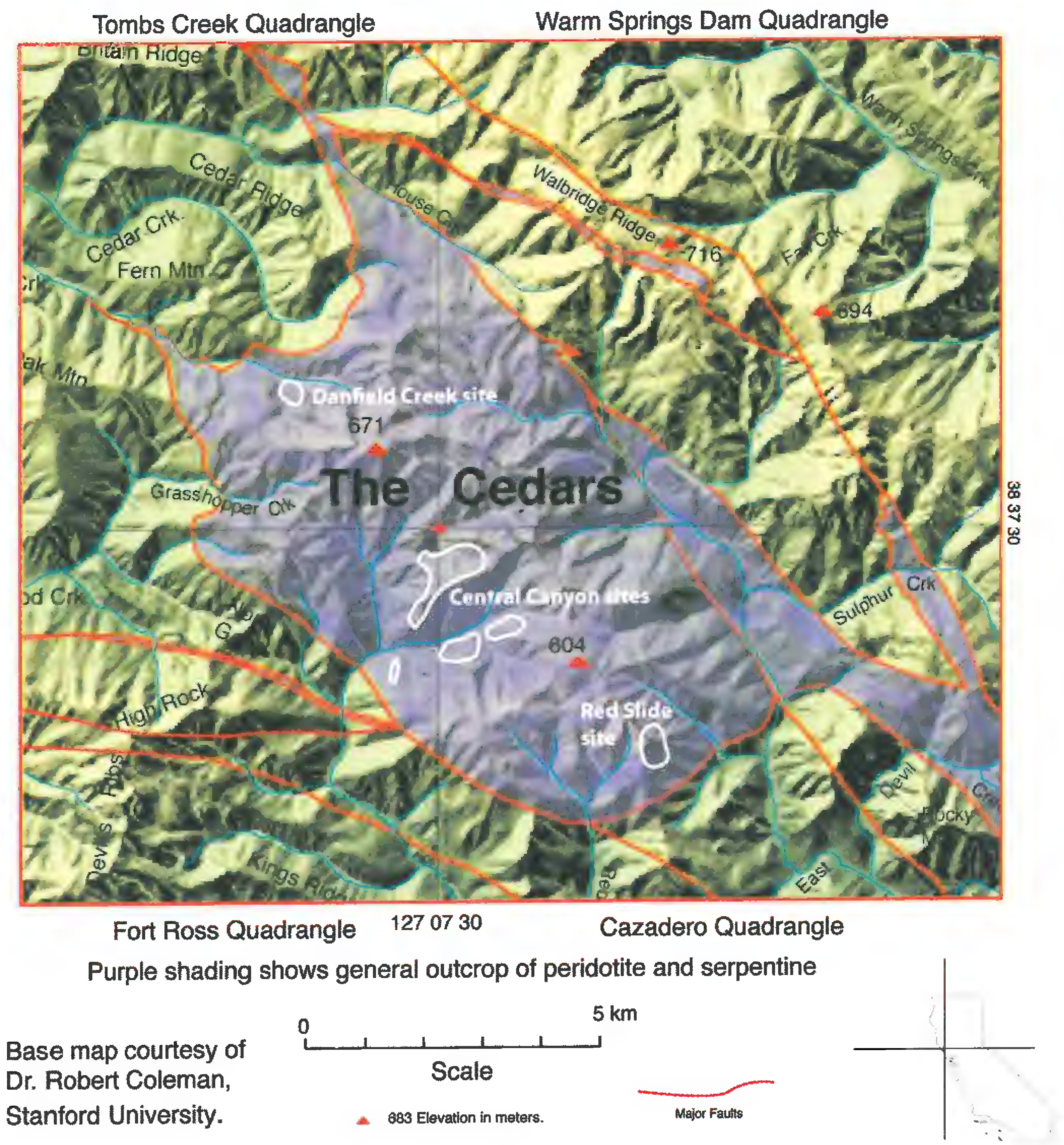

Tombs Creek Quadrangle
Warm Springs Dam Quadrangle
Britain Ridge
Cedar Ridge
Cedar Crk.
Fern Mtn
House Cr
Walbridge Ridge
716
Warm Springs Crk
Fall Crk
694
Oak Mtn
Danfield Creek site
671
The Cedars
Grasshopper Crk
Central Canyon sites
604
Sulphur Crk
Red Slide site
High Rock
Devils Rabbs
Kings Ridge
Devil
Rocky
East
38 37 30
Fort Ross Quadrangle
127 07 30
Cazadero Quadrangle
Purple shading shows general outcrop of peridotite and serpentine
0
5 km
Scale
Base map courtesy of Dr. Robert Coleman, Stanford University.
683 Elevation in meters.
Major Faults

FIG. 3. Known distribution of *Eriogonum cedrorum* at The Cedars, Sonoma Co., California.

talus but a smaller number find bare rock crevices suitable; however, those on the talus are typically larger mats. There are roughly three zones where it occurs (Fig. 3); (1) the northwest part of The Cedars in upper Danfield Creek, (2) the central upper canyons of Big Austin Creek which contains the largest population, and (3) the east side near Red Slide above East Austin Creek which also harbors a large population. There seems to be no clear reason why this taxon is so restricted to these sites while not occurring nearby. While slopes with N-facing aspect account for the majority of the plants, some are on E-, S- and W-facing slopes.

There are ±1500 to 2000 plants in existence. A recent survey of the Central Canyon sites shows the population to be extremely stable. While there were few small young plants, not a single dead mat was noted. A few plants had their crowns elevated >1.5dm above the current rock surface, showing they had undergone that much erosion and survived. Erosion of the substrate is constant but not rapid. The lack of any significant human disturbance at any site, the lack of senescence or death, and the persistence of plants in extremely harsh sites suggests this taxon is capable of great age.

Typical associates are these: *Asclepias solanoana* Woodson, *Aspidotis densa* (Brack.) Lellinger, *Cardamine californica* (Nutt.) Greene var. *sinuata* (Greene) O.E. Schulz, *Epilobium minutum* Lindl. ex Lehm., *Eriogonum luteolum* Greene, *E. nudum* Douglas ex Benth. var. *auriculatum* (Benth.) J.P. Tracy ex Jeps., *Hesperolinon spergulinum* (A. Gray) Small, *Minuartia douglasii* (Fenzl ex Torr. & A. Gray) Mattf., *Phacelia corymbosa* Jeps., *Sairocarpus vexillocalyculatus* (Kellogg) D.A. Sutton, *Streptanthus morrisonii*, and *S. barbiger* Greene. *Allium falcifolium* Hook. & Arn., *Eriophyllum lanatum* (Pursh) Forbes, and *Eschscholzia caespitosa* Benth. are more restricted to certain sites. The *Holodiscus* taxon mentioned above is the only hard-woody plant to occur within populations of *E. cedrorum*, but *Arctostaphylos bakeri* ssp. *sublaevis* and *A. viscida* Parry ssp. *pulchella* (Howell) P.V. Wells may occur peripherally.

ACKNOWLEDGMENTS

We wish to thank Dan Segal of the Plantsmen Nursery of Ithaca who brought us together with the idea that The Cedars wild buckwheat was "interesting." We also wish to thank Mrs. Bette Campbell of Cazadero for kind assistance not only to us but to a wealth of scientists over the years who have visited The Cedars. We thank Robert Coleman, Professor Emeritus of Geology at Stanford University, Palo Alto, California, for his geological map of The Cedars area that served as a base map for the plant's distribution, and Orion Johnson, a doctoral candidate at the University of Southern California, for help with the graphics. Guy Nesom kindly provided a prompt and useful review of the manuscript for which we are grateful.

REFERENCE

Reveal, J.L. 2005. 44a. Polygonaceae Jussieu subfam. Eriogonoideae Arnott, Encycl. Brittannica (ed. 7), 5:126. 1832 • Wild buckwheat subfamily. Fl. N. Amer. 5:218–478.

BOOK REVIEW

Jim Endersby. 2008. **Imperial Nature: Joseph Hooker and the Practices of Victorian Science.** (ISBN 978-0-226-20791-9, hbk.). The University of Chicago Press, 1427 East 60th Street, Chicago, Illinois 60637, U.S.A. (**Orders:** www.press.uchicago.edu, 1-773-702-7000, 1-773-702-9756 fax). $35.00, 429 pp., 49 halftones, 1 line drawing, 6" × 9".

In Jim Endersby's exposition of Joseph Hooker's role in shaping both 19th-century botanical science and the institutional development of the Royal Botanic Garden, Kew, it is immediately apparent that the key word of the title and indeed the entire book is "practices". The starting point for an understanding of scientific professionalism and its supporting institutions in 19th-century Britain lies, he argues, in neither transforming theory (e.g. Darwinian evolution) nor the new consciousness of professionalism usually attributed to a rising middle-class. It is rather in the pragmatic efforts of individuals determined to create a recognized, respectable place for science in Victorian society. For despite the very real gains made by British science over the preceding 150 years—gains attributable to individual genius, the 18th-century Enlightenment, and the tremendous interest in the natural world generated by Cook's voyages—"scientists" in the modern sense really did not exist at the onset of Queen Victoria's reign (1837). Gentlemen of independent means in the manner of Joseph Banks were still the best placed to pursue scientific inclinations.

For those who had to make a living, the route to financial security provided by a very limited number of positions in government or the nation's universities was both circuitous and precarious. This was particularly the case in the natural sciences that had no independent place in British schools and universities until the second half of the century. William Hooker, for example, despite the excellence of his own plant collections that had cost him most of his personal wealth, secured his place as regius professor of botany at the University of Glasgow only through the patronage of well-placed friends. Even after his appointment as Kew's first director he was hard-pressed to insure a future in science for his talented son Joseph.

When the younger Hooker succeeded his father as director at Kew in 1865, his principal challenge remained the establishment of a recognized, well-supported place in the public sphere for a scientific institution. If botanical science was to be as well regarded as the physical sciences, Hooker and his staff also needed to acquire the social standing that would enable them to impress on the political establishment and the British public Kew's role in national strength and well-being. "I am a *rara avis*," Hooker wrote, "a man who makes his bread by specific Botany, and I feel the obstacles to my progress as obstacles on my way to the butcher's and baker's. What is all very pretty play to amateur Botanists is death to me." (p.21) Much of what came to define Kew can be associated with this perception of the critical need to establish a sense of serious scientific and national purpose. Hooker's ban on picnics and bands in the garden's grounds, the insistence on accuracy and uniform practice among Kew's collectors, and the stress placed on Kew's importance for the economic development of the growing British empire all stemmed from Hooker's determination to win status, recognition and, above all, the public support that botanical science and its practitioners required.

Endersby's other critical insight is the connection he makes between Joseph Hooker's vision of Kew as an institution and the nature of botanical science itself. Separate chapters on classification, illustration, travel, collecting, correspondence, associations, and publishing identify the key components of the methodology of 19th-century botany. The most striking feature of a methodology based in a taxonomic approach to the world of plants is the degree to which that methodology depended on communication and uniformity of practice among men and women engaged in an increasingly global field study. Botany in isolation with its reference collection, publications, and systematic classification could hardly have sustained a claim to scientific legitimacy. Moreover, these methodological "necessities"—in an age when global empires facilitated global botanical possibilities—increasingly required an institutional scale and organization.

For readers with an interest in the history of science or in the growth and organization of institutions or for those simply intrigued with the insights and surprises the Victorians and their creations continue to yield, Endersby's clear and perceptive account is a "must read."—*Sara H. Sohmer, Dept. of History (retired), Texas Christian University, Fort Worth, Texas, U.S.A.*

A NEW NARROWLY ENDEMIC SPECIES OF *DIRCA* (THYMELAEACEAE) FROM KANSAS AND ARKANSAS, WITH A PHYLOGENETIC OVERVIEW AND TAXONOMIC SYNOPSIS OF THE GENUS

Aaron J. Floden[1], Mark H. Mayfield, and Carolyn J. Ferguson

Herbarium and Division of Biology
Kansas State University
Manhattan, Kansas 66506-4901 U.S.A.

ABSTRACT

Dirca decipiens A. Floden, sp. nov., is described from eastern Kansas and northwestern Arkansas, and a revised taxonomic synopsis and key to the genus is provided. The new species is readily distinguished from *D. palustris*, its nearest geographical congener, by its abaxially pubescent leaves and sessile flowers and fruits and from *D. mexicana* and *D. occidentalis* by differences in perianth morphology and in its possession of trichomes on the apex of the ovary and fruit. A comparative study of the phenology and habitat of the new species highlights its distinction from *D. palustris*: *D. decipiens* occupies a more isolated, xeric limestone habitat and begins flowering about a week later than the nearest populations of *D. palustris*. Phylogenetic relationships among the species of the genus were also assessed using sequence data from the internal transcribed spacer (ITS) region of the nuclear ribosomal DNA and two chloroplast DNA intergenic spacer and intron regions (*trn*D-*trn*T and *trn*L-*trn*F). The phylogenetic data support 1) the monophyly of the widespread eastern North American *D. palustris*, 2) a close relationship between *D. mexicana* and *D. decipiens*, and 3) a well-supported monophyletic group of these three eastern species that is sister to the Californian endemic *D. occidentalis*. Early divergence of the western *D. occidentalis* from the remaining species is consistent with previous biogeographic interpretations.

RESUMEN

Dirca decipiens A. Floden, nueva especie, es descrita de Kansas y el noroeste de Arkansas, y se presenta una sinopsis taxonómica revisada y una clave para el género. La nueva especie es distinguida fácilmente de *D. palustris*, su vecina geográfica más cercana, por sus hojas pubescentes en el lado abaxial, y flores y frutos sésiles, y de *D. mexicana* y *D. occidentalis* por la morfología del perianto y su posesión de tricomas en el ápice del ovario y el fruto. Un estudio de la fenología y el hábitat de la nueva especie clarifica más la distinción entre *D. decipiens* y *D. palustris*: *D. decipiens* ocupa un hábitat más aislado de piedra caliza, y empieza floreciendo aproximadamente una semana después que las poblaciones más cercanas de *D. palustris*. Las relaciones filogenéticas del género fueron evaluadas basadas en datos de secuencia de ADN (ITS; y regiones del cloroplasto, *trn*D-*trn*T y *trn*L-*trn*F). Estos datos sustentan 1) la monofilia de la especie de amplio rango en el este de Norteamérica, *D. palustris*, 2) una relación cercana entre *D. mexicana* y *D. decipiens*, y 3) un grupo monofilético bien apoyado de estas tres especies orientales que tiene una relación de hermana con la especie endémica de California, *D. occidentalis*. La divergencia temprana de la especie occidental, *D. occidentalis*, de las demás especies está de acuerdo con interpretaciones biogeográficas anteriores.

Key Words: Arkansas, *Dirca*, *decipiens*, Kansas, phylogeny, Thymelaeaceae

The genus *Dirca* L. is the only extant native North American temperate element within the largely tropical family Thymelaeaceae. This genus has most recently been considered to include three similar but geographically isolated species of North American shrubs (Nesom & Mayfield 1995). *Dirca palustris* L. occurs infrequently over most of eastern North America (from southern Ontario and northern Florida west to eastern North Dakota, eastern Oklahoma, and central Louisiana). *Dirca occidentalis* A. Gray and *D. mexicana* G.L. Nesom & M. Mayfield are both narrowly endemic species, the former occurring locally in the San Francisco Bay and Central Coast floristic provinces of California (Berman 1993; Schrader & Graves 2008) and the latter at a single locality in montane northeastern Tamaulipas, Mexico (Nesom & Mayfield 1995; Graves 2008). In the present study, we describe a fourth species of *Dirca* from Kansas and Arkansas populations that have heretofore been identified as the broadly distributed eastern species *D. palustris*.

Morphological taxonomic work on the genus *Dirca* has been extensive despite the small size of the

---

[1] Author for correspondence, present address: Herbarium and Department of Ecology and Evolutionary Biology, University of Tennessee, Knoxville, Tennessee, 37996-1610, U.S.A. (afloden@utk.edu)

J. Bot. Res. Inst. Texas 3(2): 485 – 499. 2009

genus. Following a period of recalcitrance towards taxonomic recognition of *D. occidentalis*, Vogelmann (1953) presented a detailed morphological comparison between *D. palustris* and *D. occidentalis* in which he demonstrated the taxonomic utility of foliar and stem vestiture, perianth morphology, position of filament insertion, and pedicel elongation for distinguishing these species. Vogelmann also suggested there was an overall leaf size distinction between these species but stated that additional study would be necessary to conclusively document those differences. Subsequent treatments have followed Vogelmann in recognizing both of these species. More recently, Nesom and Mayfield (1995) employed a similar combination of characters when they compared a newly discovered species—*D. mexicana*—to the other species in the genus. In the present study we additionally assessed ovary vestiture as a taxonomic character within the genus, though there has been little discussion regarding presence/absence of trichomes associated with the gynoecium (Small [1903], however, noted the ovary is glabrous in *D. palustris*).

In 1997, AJF first noticed an unusual population of *Dirca* in Johnson County, Kansas, around the time of its independent discovery and documentation by Freeman et al. (1998). In the latter, a presentation of new records for Kansas, Freeman et al. identified the single Kansas population as *D. palustris* without further consideration of its taxonomic position within the genus. Observations of living plants of both *D. palustris* and the Kansas population in the field and under cultivation over several years led AJF to pursue a more thorough comparative study of their morphology. Through the course of herbarium and field studies, at least two additional populations from Arkansas with morphological and life history traits similar to the Kansas plants were discovered. Here we present and develop these findings, which support the conclusion that these populations represent a unique species, herein described as *D. decipiens* A. Floden. We also present a taxonomic synopsis of the genus and phylogenetic data on relationships among the four *Dirca* species.

MATERIALS AND METHODS

Study of herbarium specimens.—Morphological comparisons were made between *D. decipiens* and the other three species of *Dirca*. A total of 561 specimens were examined (*D. decipiens*, 67 specimens; *D. mexicana*, 9; *D. occidentalis*, 28; *D. palustris*, 457). This included material from the three known populations of *D. decipiens*, material from the single known population of *D. mexicana*, specimens of *D. occidentalis* from all of the six counties from which it is reported, and specimens of *D. palustris* from across its broad range. A subset of specimens representing mature plants (collected six or more weeks after anthesis) was selected (*D. decipiens*, $n = 12$; *D. mexicana*, $n = 5$; *D. occidentalis*, $n = 4$; *D. palustris*, $n = 342$), and morphological measurements were made with emphasis on characters discussed in the literature (Small 1903; Holm 1921; McMinn & Forderhase 1935; Vogelmann 1953; Nesom & Mayfield 1995). Morphology assessed included the following: density and color of pubescence on twigs, leaves, involucres, ovaries, fruiting pedicel, and fruit; leaf length and width, shape of the blade and number and length of cilia on the margins (all based on the two uppermost mature leaves of each branch, as per Vogelmann [1953]); involucral bract shape and size; calyx tube and limb lengths, lobing and margin of the limb, and position of filament insertion; presence of peduncle (vs. sessile fruits), and fruit length and color. Exsiccatae were used in the study of floral characters, as possible: flowers of all species except *D. mexicana* were re-hydrated, dissected, and opened to enable morphological assessment. In addition, fresh flowers from the Kansas population of *D. decipiens* were studied, and flowers of *D. decipiens* and *D. palustris* from Arkansas were field collected in ethanol for later observation. Limited material of *D. mexicana* was available (see Nesom & Mayfield 1995); however, photos of flower dissections previously made by MHM were examined and revealed a lack of trichomes on the ovary apex (a character directly observable on specimens at the fruiting stage).

Fieldwork.—Fieldwork was conducted in the spring of 2006 in Kansas, and in spring 2007 in Arkansas, Kansas, and Missouri in order to allow simultaneous comparison of flowering material of typical *D. palustris* in close geographical proximity to *D. decipiens*. The two extant populations of *D. decipiens* in northwestern Arkansas were compared in terms of morphology and phenology to *D. palustris* in close geographical proximity (< 25 km by air).

Phylogenetic data.—Eleven samples of *Dirca* were selected for DNA sequencing to assess phylogenetic relationships among members the genus: a sample from each of seven populations of the wide-ranging *D. palustris*, two populations of *D. decipiens* (one each from Kansas and Arkansas), and one each of the narrow endemics *D. mexicana* and *D. occidentalis*. A species of *Daphnopsis* Mart. was utilized as the outgroup for the present study. While the relationship of *Dirca* to other members of the Thymelaeoideae is not well resolved (Van der Bank et al. 2002), *Daphnopsis* is a New World group in which the sequence regions considered in this study are readily alignable with *Dirca*. All voucher information is presented in Table 1.

Total DNA was extracted from silica-dried leaves or from material from herbarium specimens using a DNeasy Plant Mini Kit (Qiagen, Valencia, CA) and stored at -20°C. The internal transcribed spacer (ITS) region of the nuclear ribosomal DNA (nrDNA) was employed in this study, largely because of ease of use but also to enable comparison with a previous study in *Dirca* (Schrader & Graves 2004). Following preliminary study of several non-coding chloroplast DNA (cpDNA) sequence regions for their utility in phylogeny reconstruction for *Dirca*, two regions were selected for use: the *trn*D^{GUC}-*trn*T^{GGU} intergenic spacer region, hereafter *trn*D-*trn*T (see Demesure et al. 1995), and *trn*L^{UAA}-*trn*L^{UAA}-*trn*F^{GAA}, hereafter *trn*L-*trn*F (see Taberlet et al. 1991). PCR and sequencing conditions followed those described by Ferguson et al. (2008; for ITS, the forward modified primer ITS5 of Downie and Katz-Downie [1996] and the reverse ITS4 of White et al. [1990] were used, and the annealing temperature was 50°C).

Both forward and reverse strands were obtained for each product, and sequences were edited using Sequencher 4.5 (Gene Codes Corp., Ann Arbor, MI) and aligned manually with the aid of Se-Al (Rambaut 2002). Gaps were coded as a "fifth base"; for insertion-deletion (indel) events longer than one bp, all but one of the affected characters were excluded from analysis. Parsimony analyses were conducted using exhaustive searches in PAUP* 4.0b10 (Swofford 2002), with all characters weighted equally. Support for branches was evaluated by bootstrapping (Felsenstein 1985) using full heuristic searching with 10,000 replicates. A combined data set (ITS, *trn*D-*trn*T, *trn*L-*trn*F) was constructed and an incongruence length difference (ILD) test (Farris et al. 1995) was conducted to test for homogeneity among the ITS versus cpDNA data (implemented in PAUP*, the partition homogeneity test, branch and bound search). An analysis was then conducted on the combined data following the approach described above.

RESULTS AND DISCUSSION

***Dirca decipiens*—Compared to other species.**—*Dirca decipiens* was found to differ notably from *D. palustris*, its closest geographical neighbor (see Taxonomic Treatment, below). One of the first and strongest clues to its separation from the latter was its larger, sessile fruits, a feature it shares with the other two species, *D. occidentalis* and *D. mexicana*. As a group, these three sessile-fruited species also share a white pubescent abaxial leaf surface and trichomes on the youngest twigs. However, *D. decipiens* is distinguished from all other species of the genus in having ovaries with apical trichomes (visible in both flower and fruit) and pubescent pedicels (Fig. 1; Table 2). A suite of quantitative characters further differentiates *D. decipiens* from the other sessile-fruited endemics (e.g., compared to *D. occidentalis* and *D. mexicana*, *D. decipiens* has white abaxial leaf pubescence of higher density, generally larger leaves, and distinctive perianth traits; Table 2).

Phylogeny.—Summary data set and tree statistics are presented in Table 3, and trees resulting from analyses of the individual data sets are presented in Figure 2. All phylogenetic data support a sister relationship between the Californian endemic *D. occidentalis* and the remainder of the genus, a finding consistent with the phenograms of Schrader and Graves (2004). Sampled populations of *D. palustris* form a clade in both cpDNA phylogenies, with *D. decipiens* and *D. mexicana* exhibiting an unresolved relationship relative to *D. palustris* (*trn*D-*trn*T) or forming a clade sister to *D. palustris* (*trn*L-*trn*F; Fig. 2). However, the ITS tree differs in that one sample of *D. decipiens* is placed in the *D. palustris* clade (with weak support, 63% BS; Fig. 2). The ILD test was non-significant (P = 0.22); therefore an analysis of combined data was carried out. The combined data set consisted of 3,004 bases of aligned sequence data with 43 parsimony informative characters (Table 3). Missing data accounted for 3.7% of the combined matrix (Table 3), and most of this (3.6%) was due to a single missing sequence (*trn*D-*trn*T for *D. palustris* LA).

Table 1. Samples included in the phylogenetic study.

Taxon	Sample name	Locality	Voucher (herbarium)	GenBank accession numbers:		
				ITS	*trn*D-*trn*T	*trn*L-*trn*F
D. decipiens A. Floden, sp. nov.	*D. decipiens* KS	Johnson Co., KS	AJF 42 (KSC)	GQ471033	GQ471045	GQ471056
	D. decipiens AR	Carroll Co., AR	AJF 150 (KSC)	GQ471034	GQ471046	GQ471057
D. mexicana G.L. Nesom & M.H. Mayfield	*D. mexicana*	Tamaulipas, Mexico	E. Estrada 19855 (KSC)	GQ471035	GQ471047	GQ471058
D. occidentalis A. Gray	*D. occidentalis*	San Mateo Co., CA	R. Patterson and M. Meshriy 1984 (KSC)	GQ471036	GQ471048	GQ471059
D. palustris L.	*D. palustris* TN	Lewis Co., TN	MHM 3599 (KSC)	GQ471037	GQ471049	GQ471060
	D. palustris NJ	Cultivated material (originally from NJ)	J. Lonsdale s.n. (KSC)	GQ471038	GQ471050	GQ471061
	D. palustris AR	Newton Co., AR	AJF 154 (KSC)	GQ471039	GQ471051	GQ471062
	D. palustris LA	Caldwell Par., LA	R.D. Thomas and K. Cascio 133185 (KSC)	GQ471040	—	GQ471063
	D. palustris FL	Gadsden Co., FL	CJF and A. Gholson 274 (KSC)	GQ471041	GQ471052	GQ471064
	D. palustris MI	Iron Co., MI	E.A. Bourdo, Jr. 22179 (MSC)	GQ471042	GQ471053	GQ471065
	D. palustris MO	Shannon Co., MO	MHM 3649 (KSC)	GQ471043	GQ471054	GQ471066
Daphnopsis philippiana Krug & Urban	*D. philippiana*	Puerto Rico	C. Taylor 11700 (MO)	GQ471044	GQ471055	GQ471067

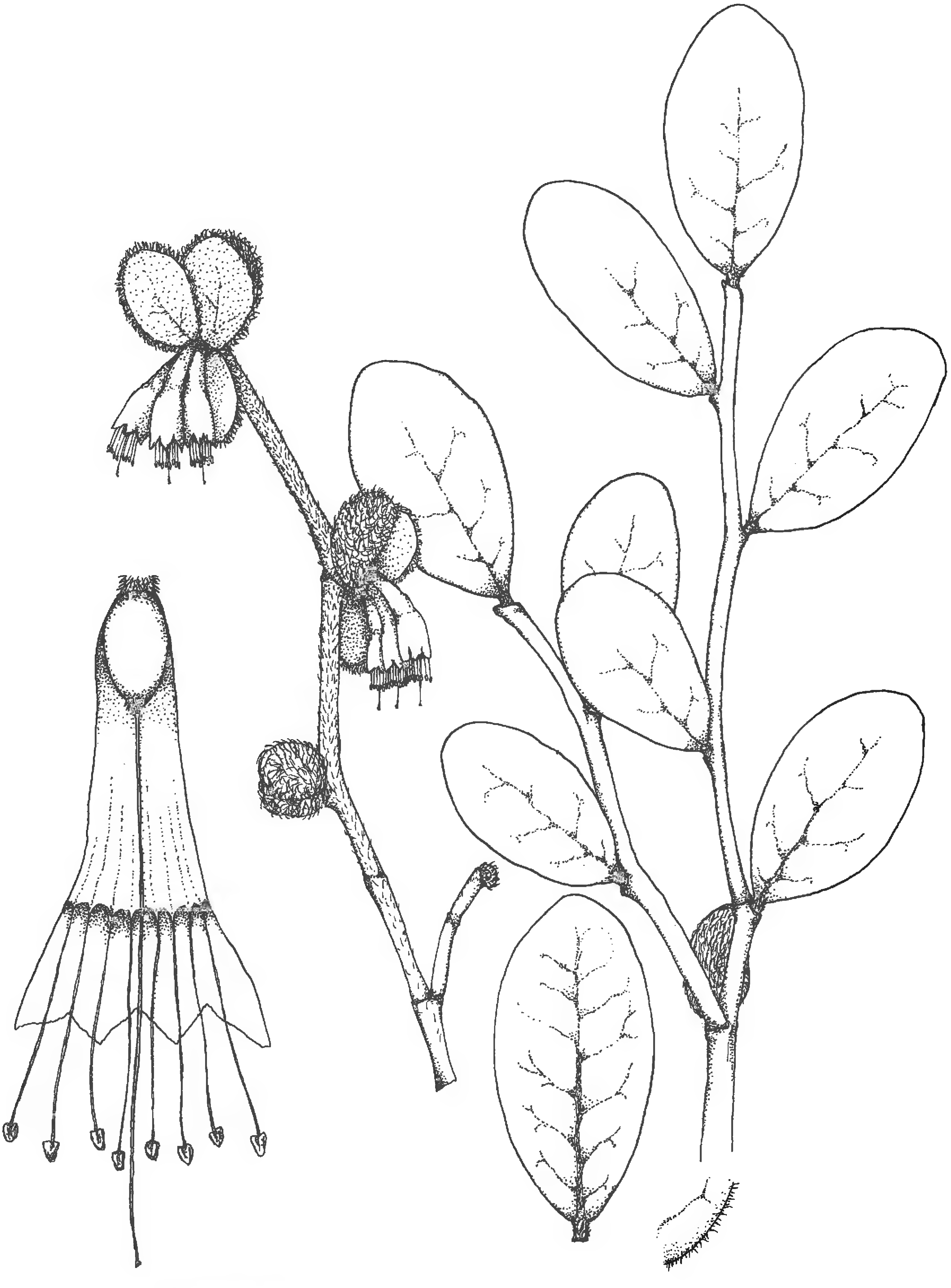


FIG. 1. *Dirca decipiens*: flowering branch, 2×; flower 10×; leaf life size; leaf margin 10×; leafy branch ½×.

TABLE 2. Comparison of morphological features of *Dirca* species. All measurements are in millimeters; averages are given in brackets, and extremes out of the average ranges are given in parentheses.

	D. occidentalis	*D. mexicana*	*D. palustris*	*D. decipiens*
Carriage	sessile–1 mm	sessile–1 mm	pedunculate, 7–20 mm	sessile–1 mm
Calyx				
length	8–10	8–10	5–8	7–11
tube	2–4	5–6	2–4	5–7
limb	lobed	lobed	unlobed	lobed
sinus depth	1–3	0.5–2	N/A	1–3
limb width	3–4	2–4	1.5–3	2.5–4
limb margin	entire	undulate	crenulate	erose
Filament insertion	proximal	distal	distal	distal
Ovary/fruit	glabrous	glabrous	glabrous	pubescent apically
Fruit length	7–8 [7.4]	7–10 [8.6]	7–9 [8.1]	8–9 [8.25]
Involucre				
pubescence	white	white	brown	white
shape	obovate-oblong	elliptic-obovate	elliptic	obovate-oblong
apex	round	acute	acute	round
immature size	4–6 × 6–12	7–2 × 3–1	1–17 × 6–8	6–18 × 5–8
mature size	4–6 × 6–12	4–6 × 6–12	2–35 × 8–15	18–5 × 8–24
Stem				
indumentum	pubescent	pubescent	glabrous	pubescent
thickness	2–4	2–4	2–4	3–6
internode	24	26	17	28
Leaves				
cilia per mm	6–9	8–12	0–3 (3–8)	11–18
cilia length	0.2–0.5 (1)	0.5–1.2	0.2–0.8	0.5–2
adaxial	pubescent	glabrous	glabrous	pubescent
abaxial	pubescent	pubescent	glabrous (pubescent)	pubescent
length	40–70	40–80	45–100	75–90
width	25–45	25–60	45–65	45–60

Figure 3 presents the strict consensus of two most parsimonious trees resulting from analysis of the combined (ITS, *trn*D-*trn*T, *trn*L-*trn*F) data. The sister relationship between *D. occidentalis* and the remainder of the genus is strongly supported (100% BS). All samples of *D. palustris* form a moderately well supported clade (87% BS; within *D. palustris*, the samples from FL and NJ group with 99% BS), and *D. decipiens* and *D. mexicana* form a moderately well supported clade (70% BS, with *D. mexicana* nested within *D. decipiens*, suggesting insufficient time since divergence to result in reciprocal monophyly). The sequence data for sampled populations of *D. palustris* exhibited variation in all three sequence regions studied, and phylogeographic and/or population genetic studies of this wide-ranging species may be informative. With regard to the new species, it is noteworthy that *D. palustris* AR is geographically proximate to *D. decipiens* AR (< 25 km by air).

The present study advances our understanding of phylogeny of this poorly known genus. Schrader and Graves (2004) presented phenograms based on ITS sequences and inter simple sequence repeat (ISSR) data for *Dirca*. As in the present study, they inferred a sister relationship between *D. occidentalis* and the remainder of the genus. The addition of data from the chloroplast and from additional samples (including the new species and populations of *D. palustris* from different parts of its range) along with cladistic analysis further refine our understanding of the phylogeny. We suggest *Daphnopsis* as an appropriate outgroup for future studies of *Dirca* (although *Daphne* has been utilized with some success by earlier workers, we were unable to align *Daphne* sequences with confidence to *Dirca*).

It is intriguing to consider morphology (Table 2) in light of the strict consensus tree (Fig. 3). Many of

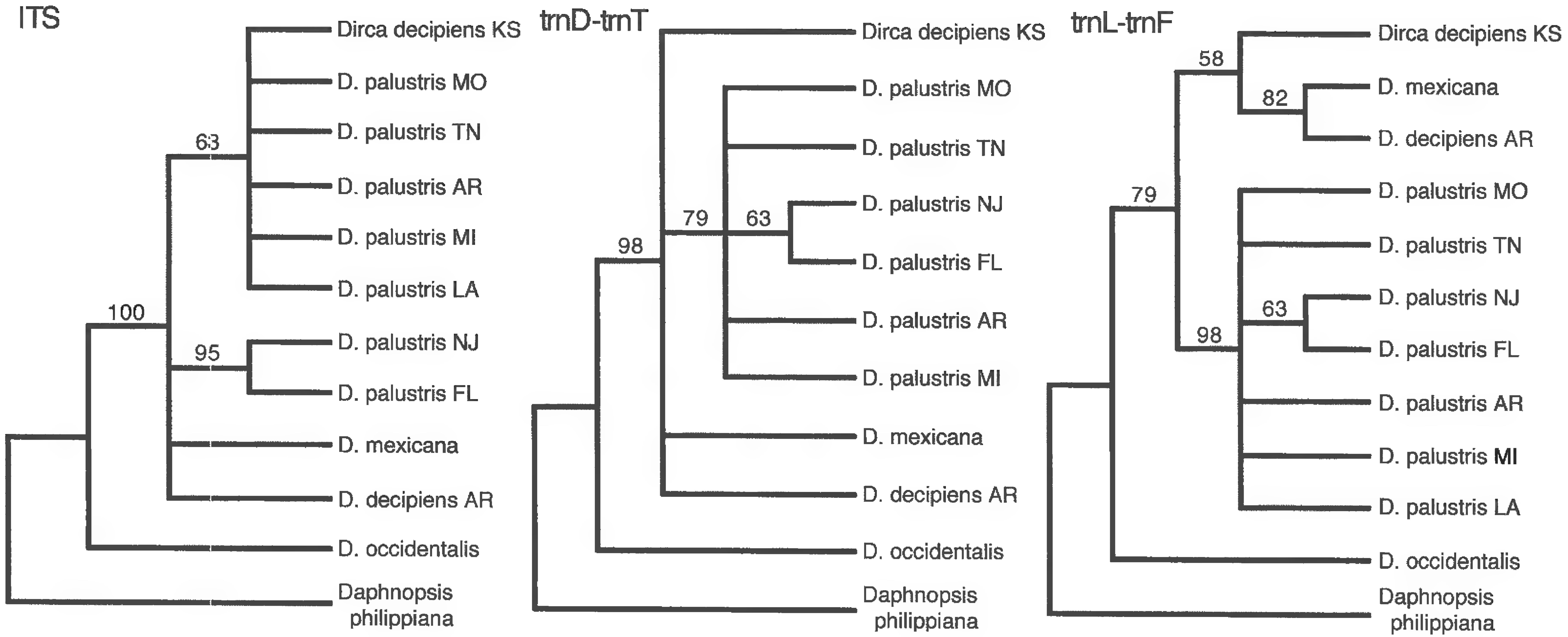

ITS
Dirca decipiens KS
D. palustris MO
D. palustris TN
D. palustris AR
D. palustris MI
D. palustris LA
D. palustris NJ
D. palustris FL
D. mexicana
D. decipiens AR
D. occidentalis
Daphnopsis philippiana
63
100
95
trnD-trnT
Dirca decipiens KS
D. palustris MO
D. palustris TN
D. palustris NJ
D. palustris FL
D. palustris AR
D. palustris MI
D. mexicana
D. decipiens AR
D. occidentalis
Daphnopsis philippiana
98
79
63
trnL-trnF
Dirca decipiens KS
D. mexicana
D. decipiens AR
D. palustris MO
D. palustris TN
D. palustris NJ
D. palustris FL
D. palustris AR
D. palustris MI
D. palustris LA
D. occidentalis
Daphnopsis philippiana
58
82
79
63
98

Fig. 2. Trees resulting from parsimony analyses of ITS (strict consensus of 2 MP trees), *trn*D-*trn*T (strict consensus of 2 MP trees) and *trn*L-*trn*F (single MP tree) data. Numbers above branches are bootstrap values > 50.

Table 3. Data set and tree statistics for the phylogenetic analyses.

Data set	ITS	***trn*D-*trn*T**	***trn*L-*trn*F**	Combined
# samples	12	11	12	12*
Sequence lengths	700–709	1260–1273	916–995	–
Aligned length	717	1287	1000	3004
% missing data	0.4%	0	0	3.7%*
# indels; no. characters excluded	17; 13	7; 32	12; 80	36; 125
# variable (included) characters	125	53	41	219
# parsimony informative (included) characters	25	9	10	46
# most parsimonious trees	2	2	1	2
MP tree length	135	54	43	237
CI	0.99	0.98	0.98	0.96
CI excluding uninformative characters	0.93	0.90	0.91	0.84
RI	0.93	0.93	0.96	0.87

*One *trn*D-*trn*T sequence was unobtainable (*D. palustris* LA), and this missing sequence accounts for the vast majority of missing data in the combined matrix.

the characters shared by the three rare taxa but not exhibited by *D. palustris* can be viewed as pleisiomorphic: more rounded leaves; abundant white pubescence on the twigs, abaxial leaf surfaces and involucres; a perianth with a more definite lobed limb; and sessile to sub-sessile fruits. The hoary, persistent, abaxial leaf pubescence, especially along the veins, has been previously noted as a characteristic of *D. mexicana* and *D. occidentalis* (Vogelmann 1953; McMinn & Forderhase 1935; Nesom & Mayfield 1995). *Dirca decipiens* is similar in this regard but the trichomes are more evenly distributed over the entire abaxial leaf surface. *Dirca palustris* is usually completely glabrous abaxially; however, we noted rare individuals that exhibit sparse, brown pubescence on the abaxial leaf surfaces and stem (see Appendix 1). Of note, the sample of *D. palustris* from Michigan (Table 1) exhibited this slight, brown pubescence, yet it grouped, as expected, with other samples of *D. palustris*. Several characteristic features of the widespread *D. palustris* are autapomorphic: elliptic-obovate leaves with cuneate bases and an acute to obtuse apex; dark brown/bronze pubescent elliptic-obovate involucres with an acute apex; an unlobed, crenate perianth margin; and pedunculate inflorescences (in fruit, both the peduncle and pedicels elongate).

Biogeographical patterns.—It is likely that the present day distribution of the genus *Dirca* is the result of range contraction in the family following a period of expansion in the Eocene and early Miocene periods when global cooling allowed elements of a widespread temperate forest to expand across the North American continent (Graham 1993; see Nesom & Mayfield 1995). Biogeographical affinities within much of the Thymelioidaeae remain to be discerned (Van der Bank et al. 2002), and our data are equivocal with regard to resolving the origin of the genus. Whatever accounts for the initial invasion of *Dirca* across North America, the drying of western North America and the uplift of the Rocky Mountains surely played a role in isolating *D. occidentalis* from eastern elements of *Dirca*, which likely remained in long-term contact during the late Miocene followed by discontinuous periods of contact during wet, cooler periods of the Pleistocene. This is shown by marked divergence between *D. occidentalis* and the other three eastern species (Fig. 3; see also discussion by Graves & Schrader 2008). Mid-Miocene conditions may have contributed to the migration of an ancestral stock along the western edge of the Ozark Plateau southward into eastern Mexico (or vice versa) and potentially eastward through the northeastern Ozark Plateau (see Graham 1993). During this time, cooling temperatures and increased aridity provided the conditions responsible for expansion of grasslands, which would have resulted in the isolation of *Dirca* into central riparian and eastern deciduous woodlands (Graham 1993; Takhtajan 1986; Wood 1972).

Current distributional patterns may have formed during the hypsithermal expansion of the Great Plains and the glacial maxima. Increasing aridity in Texas and Tamaulipas during interglacial periods would have

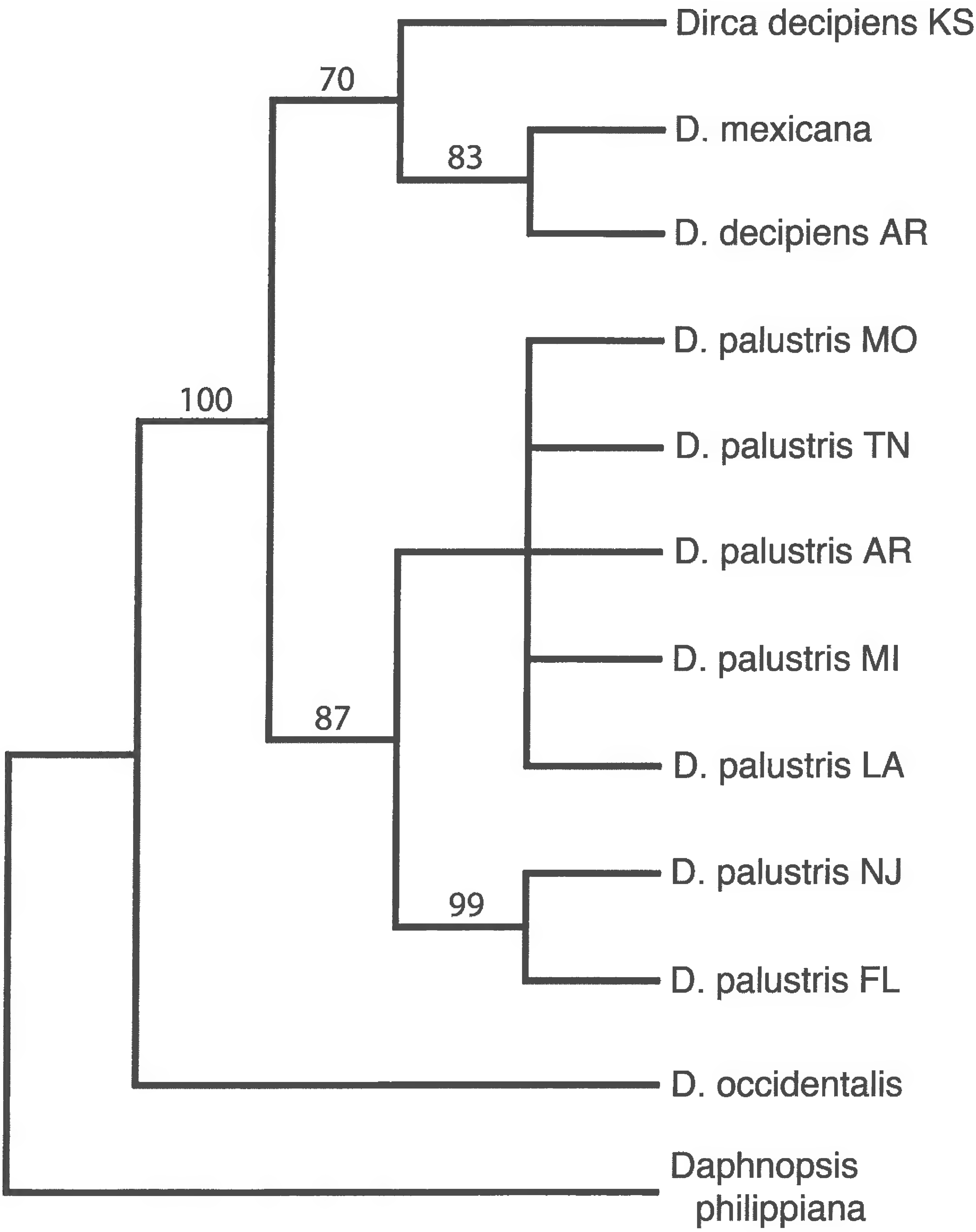

Dirca decipiens KS
70
D. mexicana
83
D. decipiens AR
D. palustris MO
100
D. palustris TN
D. palustris AR
D. palustris MI
87
D. palustris LA
D. palustris NJ
99
D. palustris FL
D. occidentalis
Daphnopsis philippiana

Fig. 3. Strict consensus of two most parsimonious trees resulting from analysis of combined (ITS, *trn*D-*trn*T, *trn*L-*trn*F) data. Numbers above branches are bootstrap values > 50.

severed the connection between the Ozarks and the forests of northeastern Mexico (see Takhtajan 1986), isolating *D. mexicana*. *Dirca mexicana* occurs in an area known for its concentration of relict species, which are present with wider distributions in the southeastern United States (e.g., *Carpinus americana*, *Carya ovata*, *Cornus florida* subsp. *urbiniana*, *Hamamelis mexicana*, *Illicium mexicanum*, *Magnolia schiediana*, *Schisandra glabra*, and *Taxus globosa* are all present in close proximity to the *D. mexicana* population; see Nesom & Mayfield 1995; see Graves 2008 for ecological habitat information for *D. mexicana*). Throughout the eastern United States, the present day distribution of *D. palustris* and its floristic associations suggest that it is a Pleistocene relict. At the southern periphery of its distribution, *D. palustris* is rare and present mostly along Pleistocene river systems–the Mississippi, Chattahoochee, Flint, and Apalachicola (Delcourt & Delcourt 1975). *Dirca palustris*, *Aquilegia canadensis*, *Enemion biternatum*, *Magnolia ashei*, *Magnolia pyramidata*, *Pachysandra procumbens*, *Phlox divaricata*, *Podophyllum peltatum*, *Taxus floridana*, and *Sanguinaria canadensis* are Pliocene/Pleistocene glacial relicts that have greater distributions further north and a local distribution in the Marianna lowlands, Red Hills of Georgia, and the Apalachicola bluffs (Delcourt & Delcourt 1975; James 1961; Kurz 1928; Mitchell 1963; Thorne 1954).

A new species in the central United States.—This study reports the unusual biological discovery of a distinctive undescribed shrubby vascular plant species from a relatively well-studied floristic region. Although two of its three known populations had been previously collected by others, *D. decipiens* had escaped taxonomic recognition despite recent taxonomic attention. Several factors likely contributed to the failure of earlier workers to recognize *D. decipiens*, including 1) its extreme rarity (apparently even prior to extensive habitat fragmentation in the region), 2) limited collecting of early spring flora, resulting in very few reproductive specimens for botanical study, and 3) a lack of close observation of living material and exsiccatae by previous workers, along with a difficulty in discerning floral characters on dried specimens. This discovery underscores the importance of continued biological collecting and study of museum collections, even in relatively well-studied regions, so that we may be able to better appreciate biodiversity (see Prather et al. 2004).

TAXONOMIC TREATMENT AND KEY TO SPECIES OF *DIRCA*

Dirca L., Sp. Pl. 1:358. 1753. Leatherwood. [From the Greek, Dirce, wife of Lycus. Dirce was a follower of Dionysus who caused a spring to flow at the site of her death.]

1. Inflorescences on elongating peduncles, projecting out of the involucral bracts; adaxial surface of involucral bracts with dark brown, rarely light brown tomentum; calyx unlobed, the margin crenate, undulate, or erose; leaves usually glabrous, rarely somewhat uniformly pubescent ____ **D. palustris**
1. Inflorescences remaining essentially sessile, glomerulate within the involucral bracts; adaxial surface of involucral bracts with white to light tan tomentum; calyx mostly 4-lobed, the margins entire to crenate; leaves and stems always uniformly pubescent to tomentulose
   2. Apex of ovary and fruit lacking trichomes; leaf margins with 12 or less cilia/mm
      3. Calyx tube (2–4 mm) shorter than the gradually flaring limb (4–6 mm), filaments inserted proximally; stems reddish brown; adaxial surface of the proximal half of the leaves pubescent along the veins; leaf margins with 6–9 cilia/mm; local in California (San Francisco Bay area) ____ **D. occidentalis**
      3. Calyx tube (5–7 mm) longer than the abruptly flaring limb (2–4 mm), filaments inserted distally; stems gray-brown; adaxial surface of the proximal half of the leaves glabrous, or rarely the lower third puberulent along the veins; leaf margins with 8–12 cilia/mm; rare and local in Tamaulipas, Mexico (mountains) ____ **D. mexicana**
   2. Apex of ovary and fruit with a few trichomes; leaf margins with 11–18 cilia/mm; rare in Kansas and Arkansas (and possibly also Missouri) ____ **D. decipiens**

Dirca decipiens A. Floden, sp. nov. (**Fig. 1**). TYPE: U.S.A. KANSAS. Johnson Co.: Overland Park Arboretum, S side of Wolf Creek on bluff, under *Quercus* sp., *Cercis canadensis*, *Carya ovata*, with *Staphylea*, *Asimina*, *Corylus*, *Erythronium albidum*, *Maianthemum*, *Polygonatum*, *Arisaema*, *Aquilegia*, 2 Apr 2007, *A.J. Floden, L. Nevling & M. Mayfield 162* (HOLOTYPE: KSC; ISOTYPES: BRIT, KANU, MO, NEB, NY, OKL, TENN, TEX, UARK, US).

Dirca mexicana similis sed ovariis ad apicem piliferis et pedicellis fructuum puberulis differt.

Soft woody shrub 2–3 × 2 m, bark tan to grayish, current growth 3–5 mm thick and flexuous, bearing persistent appressed white pubescence, sparse lenticels. *Leaves:* alternate, obovate to elliptic-oblong, 8 × 5 cm, base round, apex round, margins entire, ciliate (11–18 / mm,1–2 mm long), persistent heavily sericeous pubescent on abaxial lamina and veins, mostly glabrous above, pubescent on primary veins below midlamina, petiole to 4 mm long, heavily sericeous, deciduous. *Involucres:* obovate-oblong, cuneate base and rounded apex, first two deciduous, second two persistent and becoming leaf-like, abaxially hoary to light brown, adaxial primary veins bearing whitish sericeous hair. *Flowers:* concurrently with the leaves, sessile to sub-sessile (if so, borne on individual pedicels < 1 mm, pubescent), deflexed fascicles of 3(2–6), calyx greenish to pale yellow; narrowly cylindrical-campanulate 7–11mm long (9 mm avg.), tube 4–8 mm, limb 3–4 mm, flared, 2.5–4 mm wide, calyx limb most often divided into 4 distinct but uneven lobes 1–3 mm sinus (avg. 2 mm), occasionally unlobed, margin erose. *Stamens:* 8, distally inserted at the throat at one level, extending unequally 3–5mm beyond the calyx limb margin, pollen yellow. *Style:* 12–16 mm long, extending past stamens, stigma capitate, extending 1–5(–8) mm beyond the stamens. *Ovary:* ovoid, 2–3 mm × 1mm, 10–17 trichomes to 0.5 mm in length at the apex of ovary. *Fruit:* a one seeded drupe, sessile to subsessile, pyriform to ovoid, green, yellowing at apices at maturity, (drying reddish-brown), 8–11 mm long, 4–5 mm wide (avg. 9 × 5 mm), trichomes present on apex.

Phenology.—Flowering before the canopy has begun to leaf out in late March to early April. *Dirca palustris* in adjacent populations in Arkansas begins flowering approximately one week before *D. decipiens*. Fruits ripen sequentially from terminus of branch down over a few days, 8–10 weeks after anthesis.

Distribution.—*Dirca decipiens* is presently known from three non-contiguous locations all on northeast facing bluffs and slopes above rivers within the Appalachian Region, as classified by Takhtajan (1986). The Johnson County, Kansas, population occurs on the eastern boundary of the bluestem prairie where Ozarkian woodland elements are present in mesic valleys along riparian systems. Large prairie expanses separate *D. decipiens* in Kansas from the nearest known population of *Dirca*—a site of *D. palustris* in Benton County, Missouri. Glacial maxima reached the area just north of the Kansas population of *D. decipiens*. Many eastern deciduous woodland species are associated with the Kansas population and reach their western limits in this region (e.g. *Panax quinquefolius*, *Aralia racemosa*, *Actaea racemosa*, *Sanguinaria canadensis*, *Trillium sessile*, and *Geranium maculatum*). The two other known populations of *D. decipiens* are in northwestern Arkansas in the Ozark Highlands in Carroll County, both less than 25 km distant from the nearest *D. palustris* populations. One might seek additional populations of *D. decipiens* in southwestern Missouri, extreme eastern Kansas, and northwestern Arkansas. In fact, two historical Missouri specimens are tentatively assigned to *D. decipiens* based on vegetative features (see below); further fieldwork will be necessary to obtain reproductive material and definitively confirm *D. decipiens* from Missouri. Furthermore, suitable habitat in northwest Arkansas should be explored to determine whether the two known Arkansas populations may be contiguous.

Conservation.—The only known Kansas population, which is also the largest population, is located on public property designated as parkland. This population is healthy and composed of several thousand plants, both mature and abundant immature recruits. Both Arkansas populations are smaller in size, and both are on property that was for sale as of March, 2007. The locality near Elk Ranch seems most threatened by development due to nearby tourist destinations. The population is scattered along a rocky roadside bluff along Leatherwood Creek. One hundred to 150 plants were estimated present at the site. Very few seedling recruits were present. The population south of Metalton consists of approximately 40 individuals in a limited and rural area along a narrow gravel road. This area seems unlikely to be developed. Plants from the Kansas population have been brought into cultivation by AJF and have been distributed to correspondents in Europe and the United States and to one nursery in the United States.

Reproductive success.—Vegetative reproduction has not been documented in *D. decipiens*, although *D. mexicana*, *D. occidentalis*, and *D. palustris* do reproduce by rhizomes (McMinn & Forderhase 1935; Graves 2004). No rigorous collection of data on seed germination in *D. decipiens* has been kept by AJF, but seed propagation estimates for three years are near 95% germination. In contrast, germination rates for the other species are surprisingly low: 4.6% in *D. mexicana*, 60% in *D. occidentalis*, and 39.5% in *D. palustris* (Schrader & Graves 2005); and 61% in *D. palustris* (Del Tredici 1981). Methods of Del Tredici (1981) are effective for *D. decipiens* (AJF, unpubl.). These include allowing the ripe fruit husk to rot for one to two weeks, washing the seeds clean, potting the seeds, and leaving them to stratify over the winter (with some immediate germination, < 5%).

Etymology.—The specific epithet *decipiens*, deceiving, was chosen because of the long-standing misinterpretation of the morphology that defines this species as unique from its geographically close neighbor. It could equally be viewed as deceiving in its close morphological similarities to its more distant counterparts, *D. mexicana* and *D. occidentalis.*

Specimens examined (*A. Floden* specimens are at KSC in addition to herbaria noted in parentheses; specimens marked with an asterisk [*] are vegetative, and assignment here is tentative): **U.S.A. ARKANSAS. Carroll Co.:** N of Eureka Springs, Beaver/Elk Ranch Area, 12 Apr 1899, *W. Trelease* (MO); 18 May 1902, *B.F. Bush 1525* (MO); Leatherwood Creek, 22 Sep 1913, *E.J. Palmer 4444* (MO); 13 May 1914, *E.J. Palmer 5578* (MO); bluffs of small stream, Beaver, 27 Apr 1926, *E.J. Palmer 29826* (MO) & 29 Apr 1926, *E.J. Palmer 29837* (MO); Leatherwood Creek, 19 Mar 1927, *D. Demaree 2700* (MO); 16 Apr 1928, *D. Demaree 4785* (BRIT); Elks Ranch, 5 Apr 1942, *D.M. Moore 420010* (TEX/LL); banks of White River, near Beaver, 23 Oct 1925, *E.J. Palmer 29326* (MO); bluffs of White River, near Elk Ranch, 2 Jun 1931, *E.J. Palmer 39454* (MO); on Hwy. 187 between Nightingale Road and home [SE of road junction], opposite Leatherwood Creek on bluff top [N 36°27'57" W 93°45'32" det. by ACME Mapper 2.0 – WGS84], 22 Mar 2007, *A. Floden 150* (MO, TENN, TEX, UARK); East Fork Dry Creek, Metalton, S on Hwy 21, W on CR 524 about 3/4 mi [near N 36° 10' 15" W 93° 32' 51", det. by ACME Mapper 2.0 – WGS84], 22 Mar 2007, *A. Floden 151* (KSC, UARK, MO). **Independence Co.:** beside Cave Creek N.E. of Chinn Springs, T14N, R6W, SEC21, 17 Jun 1968, *R.D. Thomas bio. class 8733** (BRIT). **KANSAS. Johnson Co.:** Overland Park Arboretum, 38 47'45"N, 94 41'30"W det by topo map, T14S R24E Sec 25 S½SE¼, Sec 36 N½NE¼, Jct US 69 & 169, 6 m S, 1 m W, 900–1000 ft, 26 Mar 2000, *C.C. Freeman & J.A. Freeman 14078* (KANU) and 8 May 1998, *C.C. Freeman 10700* (KANU); 9 Sep 2005, *A. Floden 1*; 1 Apr 2006, *A. Floden 24*; 8 Apr 2006, *A. Floden 30*; 23 Apr 2006, *A. Floden 42*; 14 May 2006, *A. Floden 92*; 20 May 2007, *A. Floden 94.* **MISSOURI. Gasconade Co.:** W-facing wooded limestone bluffs along Gasconade River, T43N R6W NE sec 5 and [T44N R6W] SE sec 32, 2.5–5 mi S of Pershing, upper part of rocky slopes, rare, 4 Sep 1951, *J.A. Steyermark, 72691** (MO). **Oregon Co.:** base of wooded limestone bluffs along Fredericks Fork near "the Narrows," W of Calm, 11 May 1935, *J.A. Steyermark 18902** (MO).

Dirca mexicana G.L. Nesom & M. Mayfield, Sida. 16:459–467. 1995. Type: MEXICO. Tamaulipas. Municipio Hidalgo: along mountainous road from Sta. Engracia (to Dulces Nombres (Nuevo Leon), Arroyo obscuro, 2.0 mi NE of Los Caballos toward Canada El Mimbre, 15. 0 road mi W of lowermost crossing of arroyo El Mimbre, ca. 1800 m, 3 Mar 1995, *G. Nesom, M. Mayfield, & G. Anderson 7863* (holotype: MEXU; isotypes: BRIT!, KANU!, MO!, NY [internet image!], TENN!, TEX!).

Shrub to 2 m tall, branches grey-brown, lightly sericeous. Involucres hoary. Leaves broadly elliptic to slightly ovate-obovate, 4–8 cm long, 2.5–6 cm wide, base and apex round, adaxially glabrous except near petiole, abaxially sericeous mostly on veins base rounded, petiole 2–4 mm. Flowers (1)–3–(6) in axillary and terminal fascicles, deflexed, sessile to sub-sessile (if so, individually pedicellate, and glabrous), calyx clear yellow, tube longer than limb, filaments distally inserted, distinctly 4-lobed, lobes flaring at a 45 degree angle. Fruits, a drupe, ovoid, 8–10 mm long, 4–5 mm wide, yellowish on the apices.

Phenology.—Flowering early spring, late February–early March. Fruiting eight to ten weeks after anthesis, May–June.

Distribution.—Moist rocky slope in western Tamaulipas, Mexico, ca. 1800 m.

Representative specimens examined: **MEXICO. Tamaulipas. Municipio Hidalgo:** 3 Mar 1995, *G. Nesom, M. Mayfield, & G. Anderson 7863* (BRIT, KANU, MO, NY, TENN, TEX).

Dirca occidentalis A. Gray, Proc. Amer. Acad. 8:631. 1878. Type: U.S.A. California: Oakland Hills, 13 Mar 1869, *A. Kellogg & W.G.W. Harford 895* (lectotype, selected by Nevling 1964: GH; duplicate of lectotype: NY [internet image!]).

Shrubs to 2 m tall; branches red-brown, lightly sericeous. Involucres hoary. Leaves obovate to broadly ovate, 4–7 cm long, 2.5–4.5 cm wide, base rounded, apex rounded, adaxially pubescent on primary vein to mid-lamina, abaxially sparsely sericeous mostly on primary veins, petioles 2–6 mm long. Flowers 1–3(–6) in axillary and terminal fascicles, deflexed, sessile to sub-sessile (if so, individually pedicellate, and glabrous), calyx clear yellow, tube shorter than limb, distinctly 4 (3) lobed, filaments proximally inserted. Fruits, a drupe, ovoid, 8–10 mm long, 4–5 mm wide, yellowish on the apices.

Phenology.—Flowering early spring, sometimes winter, November–March, mostly late February–March. Fruiting eight to ten weeks after anthesis, (April)May–June.

Distribution.—Rich moist slopes in Alameda, Contra Costa, Marin, San Mateo, Santa Clara, and Sonoma counties around the San Francisco Bay in the range of the coastal fog belt.

Representative specimens examined: **CALIFORNIA. Alameda Co.:** flowers and fruit, 3 Feb 1920 and 8 Apr 1920, *C.C. Hall 10998* (MO). **Contra Costa Co.:** 3 Feb 1920, *C.C. Hall 10998* (MO). **San Mateo Co.:** 29 Mar 2007, *R. Patterson & M. Meshriy 1984* (KSC); Apr 1951, *A.J. Sharp* (TENN); 15 Feb 1958, *J.H. Thomas 6980* (TX/LL); 9 Mar 1964, *L.S. Rose, 64004* (TX/LL); 20 Feb 1977, *J.H. Thomas 18470* (MO); 7 Feb 1964, *D.E. Breedlove 5916* (MO).

Dirca palustris L., Sp. Pl. 1:358. 1753. TYPE: U.S.A. VIRGINIA: (LECTOTYPE, selected by Nevling 1964: LINN 501.1).

Shrub to 3 m tall; branches brown-gray, glabrous (rarely persistently pubescent). Involucres brown pubescent. Leaves obovate to ovate, 4.5–10 cm long, 4.5–6.5 cm wide, pubescent, glabrescent above, the base cuneate, the apex acute or obtuse, the petiole 2–5 mm long. Flowers (2–)3(–6) in axillary and terminal fascicles, pendent, peduncles 5–13 mm, pedicel 2–10 mm long, calyx yellow-green, tube slightly longer than limb, crenulate, undulate, or erose, filaments distally inserted. Fruits, a drupe, ovoid, 8–12 mm long, 4–5 mm wide, yellowish on the apices.

Phenology.—Flowering early spring, March–May, fruiting eight to ten weeks after anthesis, May–July.

Distribution.—Rich mesic slopes above streams, lowland along rivers, calcareous woodland; N.B., Ont., Que.; Ala., Conn., Del., Fla., Ga., Ill., Ind., Iowa, Ky., La., Mass., Md., Maine, Mich., Minn., Mo., N.C., N.D., N.H., N.J., N.Y., Ohio, Okla., Pa., R.I., S.C., Tenn., Va., Vt., Wis. *Dirca palustris* occurs infrequently within a broad area mostly within the bounds of the Appalachian province of eastern North America but is widely scattered and of local occurrence.

Common Names.—American mezereon, eastern leatherwood, harbinger of spring, leatherwood, moosewood, rope bark, wicopy.

Representative specimens examined: **U.S.A. ALABAMA. Clarke Co.:** 27 Mar 1969, *R. Kral, 34034* (TENN). **Monroe Co.:** 17 Apr 1983, *B.E. Wofford & Z. Murrell 83-42* (TENN). **ARKANSAS. Newton Co.:** 22 Mar 2007, *A. Floden 156* (KSC); 22 Mar 2007, *A. Floden 154* (KSC); 22 Mar 2007, *A. Floden 153* (KSC). **Stone Co.:** 1 Jul 1969, *E.M. Browne* and *E.T. Browne 69G4.8* (TENN). **KENTUCKY. Franklin Co.:** *25* May 1879, *R.H. Wildburger 2451* (KSC). **Carter Co.:** 22 May 1965, *E.M. Browne & E.T. Browne 10151* (TENN). **LOUISIANA. Catahoula Parish:** *M.H. Mayfield & C.J. Ferguson 2293* (KSC). **MARYLAND. Montgomery Co.:** 4 Apr 1920, *S.F. Blake 8062* (TX/LL). **MICHIGAN. Ingham Co.:** 20 Apr 1963, *L.C. Anderson 2228* (KSC). **MINNESOTA. Becker Co.:** 6 May 1986, *V. McNeilus* (TENN). **MISSISSIPPI. Marion Co.:** 1 Apr 1984, *S. McDaniel 27629* (TENN). **Wayne Co.:** 16 Mar 1975, *K.E. Rogers 9428-A* (TENN); 19 Mar 1977, *S. McDaniel 21171* (MO). **NORTH CAROLINA. Chatham Co.:** 9 Apr 1960, *H.E. Ahles* and *J. Haesloop 53191* (TENN) **OKLAHOMA. McCurtain Co.:** 28 Aug 1976, *J. Taylor 23358* (TENN). **TENNESSEE. Lewis Co.:** 23 Mar 2006, *M.H. Mayfield 3649,* (KSC). **VERMONT. Orange Co.:** 4 Jun 1966, *F.C. Seymour 23613* (TENN). **Caledonia Co.:** 11 Jun 1982, *D.E. Boufford* and *D.S. Conant 22913* (TENN). **VIRGINIA. Pulaski Co.:** 17 Apr 1975, *R. Kral 55124* (TX/LL). **WEST VIRGINIA. Wirt Co.:** 9 Apr 1955, *E.A. Bartholomew W-4024* (TENN). **Wayne Co.:** 8 Apr 1938, *F. Gilbert* and *L. Williams 673* (TENN). **CANADA. Quebec: D'Iberville Co.:** 5 May 1935, *F. Marie-Victorin & F. Rolland-Germain 43268* (TX/LL). **Ontario:** 11 May 1941, *H.A. Senn & M.N. Zinck 162* (TENN).

APPENDIX 1

List of *Dirca palustris* specimens exhibiting abaxial leaf pubescence; voucher information followed by herbarium acronym.

U.S.A. DELAWARE. Wilmington, 1876, *G.W. Letterman* (MO). **MASSACHUSETTS** (Pl. H. Kohankie, Painesville, O., 1928): Jamaica Plain, Arnold Arboretum, Harvard University, 16 Apr and 25 Jul 1941, *R.B. Clark 20656* (MO). **MICHIGAN. Cheboygan Co.:** in the beech-maple forest on Colonial Point, 9 Aug 1922, *F.C. Gates 13390* (KSC). **Iron Co.:** Pewabic State Park at Fortune Lake, 15 Aug 1970, *E.A. Bourdo Jr. 22197* (MSC). **MINNESOTA:** hardwood forest, across lake from Ingersand, Sand Lake, 24 Jul 1926, *A.M. Johnson 2019* (MO). **NEW JERSEY. Warren Co.:** bluffs of Delaware River, Phillipsburg, 5 Jun 1910, *K.K. Mackenzie 4584A* (MO). **Salem Co.:** wet woods along Major Run, 1.5 mi S of Sharptown, 24 Jun 1935, *J.M. Fogg Jr. 8844* (MO). **Salem Co.:** rich, wooded slope along Culliers Run, 1.5 mi NE of Welchtown, 29 Apr 1936, *J.W. Adams 2846* (MO). **NEW YORK. Washington Co.:** woods, Pilot Knob, E side of Lake, George, 30 Aug 1944, *H.D. House 28695* (LL/TX). **RHODE ISLAND (?):** Fls Lyndonville, Lvs Fr. Charlotte, May 1877 and 20 Jun 1876, *C.S. Pringle* (MO). **VERMONT:** rich woods, Brandon, alt. 500 ft, 30 Apr and 8 Sep 1924, *D.L. Dutton* (KSC). **Chittenden Co.:** woods, Essex, 3 Aug 1911, *S.F. Blake 2511* (LL). **WEST VIRGINIA. Monroe Co.:** bank of Second Creek, 2 Jul 1941, *A.J. Sharp.*

CANADA. ONTARIO. Halton Co.: Loc. 443 2 mi E. of Rockwood near Blue Springs, 24 May 1956, *J.H. Soper & G. Fleischmann 6192* (MO).

ACKNOWLEDGMENTS

We thank Eduardo Estrada, John Lonsdale, Matt Meshriy, and Bob Patterson for collecting and sending important plant material; personnel of the Overland Park Arboretum (Johnson Co., KS) and San Mateo County Parks (CA) for permitting assistance; the staff of MSC for allowing us to sample tissue from an herbarium specimen; the staff of MO for sending silica-dried material of *Daphnopsis philippiana*; Shannon Fehlberg and Mary Andreopolous for assistance with molecular work; and Deyka Garcia for assistance with the spanish abstract. We are grateful to Lorin Nevling for discussion of *Dirca* biogeography and morphology, to Bill Graves, Guy Nesom, and Gene Wofford for valuable comments on an earlier version of the manuscript, and to Guy Nesom and Bob Patterson for valuable comments during manuscript review. We acknowledge the following herbaria for loans of specimens: BRIT, KANU, LL/TEX, MSC, MO, and TENN. This work was partially supported by NSF DBI-0544980 (CJF and MHM) and the Kansas Agricultural Experiment Station (Contribution No. 10-011-J).

REFERENCES

Berman, R.J. 1993. Thymelaeaceae. In: J.C. Hickman, ed. The Jepson manual: higher plants of California. University of California Press, Berkeley. Pp. 1080–1081.

Delcourt, H.R. and P.A. Delcourt. 1975. The blufflands: Pleistocene pathway into the Tunica hills. Amer. Midland Naturalist 94:385–400.

del Tredici, P. 1984. Propagating leatherwood: a lesson in humility. Arnoldia 44:20–24.

Demesure, B., N. Sodzi, and R.J. Petit. 1995. A set of universal primers for amplification of polymorphic non-coding regions of mitochondrial and chloroplast DNA in plants. Molec. Ecol. 4:129–131.

Downie, S.R. and D.S. Katz-Downie. 1996. A molecular phylogeny of Apiaceae subfamily Apioideae: evidence from nuclear ribosomal DNA internal transcribed spacer sequences. Amer. J. Bot. 83:234–251.

Farris, J.S., M. Källersjö, A.G. Kluge, and C. Bult. 1995. Testing significance of incongruence. Cladistics 10:315–319.

Felsenstein, J. 1985. Confidence limits on phylogenies: an approach using the bootstrap. Evolution 39:783–791.

Ferguson, C.J., S.D. Fehlberg, K.A. Ford, and S.C. Strakosh. 2008. Phylogenetic relationships of the genus *Phlox* (Polemoniaceae): comparing and combining data sets from the chloroplast genome. In: A.K. Sharma and A. Sharma, eds. Plant genome: biodiversity and evolution. Science Publishers, Enfield, NH. Pp. 153–172.

Freeman, C.C., R.L. McGregor, and C.A. Morse. 1998. Vascular plants new to Kansas. Sida 18:593–604.

Graham, A. 1993. History of the vegetation: Cretaceous (Maastrichtian)–Tertiary. In Flora of North America, Vol. 1. Oxford University Press, New York. Pp. 57–70.

Graves, W.R. 2004. Confirmation that *Dirca* spp. (Thymelaeaceae) reproduce from rhizomes. Rhodora 106: 291–294.

Graves, W.R. 2008. Habitat and reproduction of *Dirca mexicana* (Thymelaeaceae). Rhodora 110:365–378.

Holm, T. 1921. *Dirca palustris* L. a morphological study. Amer. J. Sci. 2:177–182.

James, C.W. 1961. Endemisms in Florida. Brittonia 13:225–244.

Kurz, H. 1928. Northern aspect and phenology of Tallahassee Red Hills flora. Bot. Gaz. 85:83–89.

McMinn, H.E. and B. Forderhase. 1935. Notes on western leatherwood, *Dirca occidentalis* Gray. Madroño 3: 117–120.

Mitchell, R.S. 1963. Phytogeography and floristic survey of a relic area in the Marianna lowlands, Florida. Amer. Midland Naturalist 69:328–366.

Nesom, G.L. and M.H. Mayfield. 1995. A new species of *Dirca* (Thymelaeaceae) from the Sierra of northeastern Mexico. Sida 16:459–467.

Nevling, L.I., Jr. 1964. Typification in *Dirca*. J. Arnold Arbor. 45:158–159.

Prather, L.A., O. Alvarez-Fuentes, M.H. Mayfield, and C.J. Ferguson. 2004. The decline of plant collecting in the United States: a threat to the infrastructure of biodiversity studies. Systematic Botany 29:15–28.

Rambaut A. 1996. Se-Al: sequence alignment editor. Software available at http://evolve.zoo.ox.ac.uk/

Schrader, J.A. and W.R. Graves. 2004. Systematics of *Dirca* (Thymelaeaceae) based on ITS sequences and ISSR polymorphisms. Sida 21:511–524.

Schrader, J.A. and W.R. Graves. 2005. Seed germination of *Dirca* (leatherwood): pretreatments and interspecific comparisons. HortScience 40:1838–1842.

Schrader, J.A. and W.R. Graves. 2008. At the interface of phylogenetics and population genetics, the phylogeography of *Dirca occidentalis* (Thymelaeaceae). Amer. J. Bot. 95:1454–1465.

Small, J.K. 1903. Flora of the southeastern United States. New Era Printing Company, Lancaster, PA.

Swofford, D.L. 2002. PAUP*: phylogenetic analysis using parsimony (and other methods), version 4.0b10. Sinauer, Sunderland, MA.

Taberlet, P., L. Gielly, G. Pautou, and J. Bouvet. 1991. Universal primers for amplification of three non-coding regions of chloroplast DNA. Pl. Molec. Biol. 17:1105–1109.

Takhtajan, A.L. 1986. Floristic regions of the world. University of California Press, Berkeley.

Thorne, R.F. 1954. The vascular plants of southwestern Georgia. Amer. Midland Naturalist 52:257–327.

van der Bank, M., M.F. Fay, and M.W. Chase. 2002. Molecular phylogenetics of Thymelaeaceae with particular reference to African and Australian genera. Taxon 51:329–339.

Vogelmann, H. 1953. A comparison of *Dirca palustris* and *Dirca occidentalis* (Thymelaeaceae). Asa Gray Bull. 2:77–82.

White, T.J., T. Bruns, S. Lee, and J. Taylor. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In M.A. Innis, D.H. Gelfand, J.J. Sninsky and T.J. White, eds. PCR protocols: a guide to methods and applications. Academic Press, San Diego. Pp. 315–322.

Wood, C.E., Jr. 1972. Morphology and phytogeography: the classical approach to the study of disjunctions. Ann. Missouri Bot. Gard. 59:107–124.

BOOK REVIEW

C.T. BRYSON AND M.S. DEFELICE (EDS.), WITH A.W. EVANS (PHOTOGRAPHS). 2009. **Weeds of the South.** (ISBN 978-0-8203-3046-4, flexibind). The University of Georgia Press, 330 Research Drive, Athens, Georgia 30602-4901, U.S.A. (**Orders:** www.ugapress.org, 1-800-266-5842). $39.95, 498 pp., 1500 color photographs, 125 illustrations, 405 maps, 7 1/2" × 10".

Weeds of the South is a thick book, with 498 pages, nicely produced and bound. Credits for the species write-ups are given to 44 contributors in various combinations, listed at the back. Surprisingly, though, there's no list of the species included (the Contents lists only families). By my count, the book includes 400 species in 65 families. The geographic coverage "extends from Virginia along the Ohio River valley to Missouri, across Oklahoma, and south to Texas and Florida", and almost all species included are herbaceous. The photos (all by Arlyn Evans) are rightly advertised as a major strength of the book—all are excellent, and a close-up of seeds and a seedling is included for each species. Also provided is information under headings of "Synonyms," "Habit, Habitat, and Origin," "Seedling Characteristics," "Mature Plant Characteristics," "Special Identifying Features," and "Toxic Properties."

From the brief Introduction—Weeds are "plants that alter the structure of natural communities; interfere with the function of ecosystems; or have negative effects on people, agriculture, or other societal interests. Any plant can be a weed in one situation and unobtrusive or even desirable in another. In other words, one person's weed is another person's wildflower." "Weeds are usually plants that grow spontaneously and prolifically in habitats that have been modified by human activity." "Clearing for cultivation and urban development … continues to provide habitats for many introduced and native species to become weedy." Although not explicit anywhere, the primary criterion for inclusion in the book perhaps is a need for management—"Weed management requires early and accurate identification to ensure the correct control practices. In most cases, it is necessary to identify weeds early in their seedling stages when they are easier to manage."

To the extent that *Weeds of the South* is intended to provide a means of identification for plants growing in disturbed sites, it will be a good help. But insofar as it's intent to suggest which should be managed and controlled, without caveat, the book is misleading. 193 of the 400 total species are native to the USA! 207 herbaceous non-native species is a good sample, but there is no perspective to guide land managers in distinctions between the natives and non-native invasives.

Of the 69 Asteraceae species mentioned, 44 are natives, including *Ageratina altissima, Coreopsis tinctoria, Dracopis amplexicaule, Erigeron philadelphicus, Grindelia squarrosa, Rudbeckia hirta, Symphyotrichum pilosum, Vernonia baldwinii*, and *Vernonia gigantea*. OUCH! These are native species, conspicuously beautiful, and don't deserve to be book-enshrined with a bad rap in North America. Here's the whole list of native Asteraceae, including *Ambrosia trifida* and *Eclipta prostrata*, which are mistakenly identified in the book as non-natives: *Acanthospermum hispidum, Ageratina altissima, Ambrosia artemisiifolia, A. bidentata, A. grayi, A. trifida, Amphiachyris dracunculoides, Bidens bipinnata, B. frondosa, Cirsium discolor, C. horridulum, Conyza canadensis, C. ramosissima, Coreopsis tinctoria, Dracopis amplexicaule, Eclipta prostrata, Erigeron philadelphicus, E. strigosus, Eupatorium capillifolium, Flaveria trinervia, Grindelia ciliata, G. squarrosa, Gutierrezia sarothrae, Helenium amarum, H. autumnale, Helianthus annuus, H. ciliaris, H. divaricatus, H. grosseserratus, H. petiolaris, H. tuberosus, Heliopsis helianthoides, Lactuca floridana, Packera glabella, Pyrrhopappus carolinianus, Rudbeckia hirta, Solidago canadensis, S. altissima, Symphyotrichum divaricatum, S. pilosum, Verbesina encelioides, Vernonia baldwinii, V. gigantea*, and *Xanthium strumarium*. The 25 non-natives: *Achillea millefolium* (without caveat in the book regarding its partially native status), *Anthemis cotula, Arctium minus, Carduus nutans, Centaurea biebersteinii, C. cyanus, C. solstitialis, Cichorium intybus, Cirsium arvense, C. vulgare, Conyza bonariensis, Galinsoga quadriradiata, Leucanthemum vulgare, Matricaria discoidea, Parthenium hysterophorus, Senecio vulgaris, Silybum marianum, Soliva sessilis, Sonchus arvensis, S. asper, S.oleraceus, Tanacetum vulgare, Taraxacum officinale, Tragopogon dubius*, and *Xanthium spinosum*.

Maybe the pattern doesn't hold so obviously in other families? Let's see. Of the 5 Onagraceae species, all are natives: *Ludwigia decurrens, L. peploides, Oenothera biennis, O. laciniata*, and *O. speciosa*. Of the 14 Euphorbiaceae species, 11 are native. Beans, grasses, and some other families have a higher proportion of non-natives. More examples of weeds, all native, in miscellaneous families: *Andropogon virginicus, Brunnichia ovata, Cocculus carolinus, Desmanthus illinoensis, Campsis radicans, Hoffmannseggia glauca, Lupinus perennis, Myosurus miminus, Nuttallanthus canadensis, Parthenocissus quinquefolia, Passiflora incarnata, P. lutea, Phytolacca americana, Saururus cernuus, Tripsacum dactyloides, Verbena bracteata*. The very first three species in the book are *Equisetum arvense, E. hyemale*, and *Pteridium aquilinum*.

Yes, many of these natives often grow in disturbed habitats, but does *Weeds of the South* imply that these be seen and treated the same as the non-native species? It's disappointing to see *Pontederia cordata* and *Eichhornia crassipes* presented in the same context, with no essential distinction drawn between them. And then, there are so many places in the South where it would be wonderful to see *Vernonia baldwinii* growing instead of *Sonchus asper*. Finally, there's no paucity of ecologically damaging alien invaders, easily enough and more in the South to fill the space of this book. Why not *Salvinia mimina* and *S. molesta, Myriophyllum aquaticum, Lygodium japonicum, Bothriochloa ischaemum, Centaurea melitensis, Torilis arvensis*, and others?—*Guy Nesom, botanist, guynesom.com, Fort Worth, Texas, U.S.A.*

J. Bot. Res. Inst. Texas 3(2): 500. 2009

TWO NEW COMBINATIONS IN *TRYPHANE* (ALSINACEAE)

W.A. Weber and R.C. Wittmann

University of Colorado Museum
UCB 265
Boulder, Colorado 80309, U.S.A.
bill.weber@colorado.edu

ABSTRACT

Two scientific names in the genus *Tryphane* are validly published.

RESUMEN

Dos nombres científicos del género *Tryphane* se publican como válidos.

Áskell and Doris Löve (1976) treated *Minuartia* as several smaller paraphyletic genera, including *Lidia, Alsinanthe,* and *Tryphane.* Evidently their arguments for this have been ignored. Their discussion follows:

> The redefinition of the strictly Mediterranean genus *Minuartia* L. by Hiern (1899), which made it possible to accommodate within its limits even arctic species, certainly was caused by a misunderstanding of considerable magnitude, although later authors and even two monographers (Mattfeld 1921, 1922; McNeill 1962) seem to have accepted this without hesitation. The group so widely defined is highly unnatural from whatever modern point of view it is looked upon, as shown most clearly by the apparent difficulties experienced by McNeill in dividing it into subgenera, sections, and even subsections and series, some of which are not only morphologically heterogeneous but also characterized by distinct basic chromosome numbers and by karyomorphology different from that of their supposedly closest relatives.
>
> *Minuartia* s. str. is known to have the basic chromosome number x = 15, whereas other groups within the collective genus have been reported to have basic numbers as variable as x = 8, 9, 10, 11, 12, 13, and 23. We have had the opportunity to make cytotaxonomical studies, still mainly unpublished, of considerable living and herbarium material of numerous species from arctic and boreal regions in Eurasia and North America and also of populations from the Mediterranean and the southwestern Asiatic area of the collective genus. These studies, which also include detailed observations on pollen and seed coat morphology, have convinced us that this unnatural assemblage needs to be divided into groups that better fit the modern biological definition of a genus.
>
> Therefore, in the *Cytotaxonomic Atlas of the Arctic Flora* (Löve & Löve 1975) we have resuscitated some long ignored but well-defined and more restricted genera that are represented in the tundra of the north lands, and proposed new names for a couple of groups for which valid names at that level were not available.

The authors went on to discuss *Porsildia, Wierzbickia, Lidia, Alsinanthe, Tryphane* and *Neumayera*, noted their chromosome numbers, and provided a useful key to the genera, but while they made new combinations in *Alsinanthe, Porsildia,* and *Lidia,* they evidently neglected making any in *Tryphane*, a genus proposed by Reichenbach (1841). We adopted three of these genera in the *Colorado Flora* (Weber & Wittmann 2001) and followed the nomenclature as given in Löve (1983).

In his Icelandic flora Á. Löve (1983: 194) used the combination *Tryphane rubella*, attributing the authorship to Reichenbach. He also listed a subspecies *propinqua* (Richardson) Löve & Löve. Neither name appears to have been published hitherto. Search as we might in his bibliography (Weber 1995), we have not been able to find a place wherein Áskell and Doris made the combinations. As Áskell often said, "Even Jove nodded."

Rabeler et al. (2005) cite, without discussion, *Tryphane rubella* (Wahlenberg) Reichenbach as a synonym of *Minuartia rubella* (Wahlenberg) Hiern. We agree that the various varieties and subspecies mentioned as synonyms are trivial.

To resolve this problem and use the names, we propose to validate them as follows:

Tryphane rubella (Wahlenb.) A. & D. Löve ex W.A. Weber., comb. nov. Basionym: *Alsine rubella* Wahlenb., Flora Lapp. 128, pl. 6. 1812.

Tryphane rubella subsp. **propinqua** (Richardson) A. & D. Love ex W.A. Weber, comb. nov. Basionym: *Arenaria propinqua* Richardson, in J. Franklin, Narr. Journey Polar Sea 738. 1823.

ACKNOWLEDGMENTS

We are indebted to Kanchi Gandhi for bringing this problem to our attention and for commenting on an earlier draft of the paper.

REFERENCES

Löve, Á. 1983. Iceland's flora. Reykjavik.

Löve, Á. and D. Löve. 1975. Cytotaxonomic atlas of the arctic flora. J. Cramer, Vaduz.

Löve, Á. and D. Löve. [1975] 1976. Nomenclatural notes on Arctic plants. Bot. Not. 128:497–523.

Rabeler, R.K., et al. 2005. *Minuartia.* In: Flora of North America Editorial Committee, eds. Flora of North America North of Mexico. 5(2):134.

Reichenbach, (H.G.) Ludwig. 1841. Flora Germanica. 28:28–29, 32.

Weber, W.A. 1995. A bibliography of the published works of Áskell Löve. Acta Bot. Islandica 12:6–34.

Weber, W.A. and R.C. Wittmann. 2001. Colorado flora. Eastern and Western Slopes. Third edition, two volumes. Univ. Press of Colorado.

TWO NEW SPECIES OF *SOLANUM* FROM ECUADOR AND NEW COMBINATIONS IN *SOLANUM* SECTION *PACHYPHYLLA* (SOLANACEAE)

Stephen R. Stern and Lynn Bohs

Department of Biology
University of Utah, 257 S. 1400 E.
Salt Lake City, Utah 84112, U.S.A.
stern@biology.utah.edu, bohs@biology.utah.edu

ABSTRACT

Two new species of *Solanum* from Ecuador are described here. **Solanum manabiense** S. Stern is a member of *Solanum* section *Gonatotrichum*. It is most similar to *S. deflexum*, *S. turneroides*, and *S. hoffmanseggii* but differs in a unique combination of straight hairs, a rhizomatous habit, and seeds lacking swollen margins and an apical notch. It is appears to be endemic to the Pacific coast of Ecuador and has been named after the Manabí province where the type was collected. **Solanum zumbense** Bohs, named for the town of Zumba in southern Ecuador, is a member of *Solanum* section *Pachyphylla*. It is most similar to *S. obliquum*, but differs in having abundant long hairs on the foliage and axes, acute fruits, purplish, nearly glabrous corollas, and very long filaments. One new name and three new combinations are also validated in *Solanum* section *Pachyphylla*.

RESUMEN

Se describen aquí dos especies nuevas de *Solanum* de Ecuador. **Solanum manabiense** S. Stern es un miembro de *Solanum* sección *Gonatotrichum*. Esta especie es similar a *S. deflexum*, *S. turneroides*, y *S. hoffmanseggii*, pero se diferencia por tener una combinación única de pelos rectos, un hábito rizomatoso, y semillas sin márgenes hinchados ni muesca apical. Parece que es endémica a la costa pacífica del Ecuador y toma su nombre de la provincia de Manabí de donde se recolectó el tipo. **Solanum zumbense** Bohs ha sido nominada en honor al pueblo de Zumba del sur de Ecuador; esta especie es miembro de *Solanum* sección *Pachyphylla*. Es parecida a *S. obliquum*, pero se diferencia por sus frutos puntiagudos, flores de corola morada y casi glabra, y filamentos largos. También se publican un nombre y tres combinaciones nuevas en *Solanum* sección *Pachyphylla*.

Two New Species of *Solanum* from Ecuador

A comprehensive project to complete a species-level taxonomic treatment of the entire genus *Solanum*, supported by the National Science Foundation Planetary Biodiversity Inventory program, has facilitated detailed taxonomic study of many little-known groups within this giant genus (Knapp et al. 2004; http://www.nhm.ac.uk/solanaceaesource). Herbarium study and field work associated with this project have uncovered two undescribed *Solanum* species from Ecuador, which are treated below.

One of the species, *Solanum manabiense* S. Stern, belongs to *S.* section *Gonatotrichum*, a group of about five species with a disjunct distribution between Central and South America. Members of *S.* section *Gonatotrichum* include *S. deflexum* Greenm. and *S. lignescens* Fernald from Central America, *S. turneroides* Chodat and *S. hoffmanseggii* Sendtn. from northern Argentina, Bolivia, Paraguay, and into the Mato Grosso do Sul region of Brazil, and *S. adscendens* Sendtn., endemic to southern Brazil. Molecular phylogenetic analyses indicate that members of *S.* section *Gonatotrichum* form a monophyletic group that is part of the Brevantherum clade of Bohs (2005) and Weese and Bohs (2007). Species of this group are distinctive in the genus due to their explosive fruit dehiscence. The fruits are watery, with a thin exocarp, and build up internal pressure as they mature until they burst, explosively expelling the seeds. Plants of this group are generally diminutive annuals or herbaceous perennials with short, few-flowered inflorescences and simple, sometimes geniculate hairs. This group was studied by Nee (1989), who recognized two species. However, Nee annotated a specimen of the new species described below as *S. manabiense*, as *S. deflexum* vel. aff., which he later synonymized with *Solanum adscendens*. Detailed taxonomic study has reevaluated the circumscription and species limits of section *Gonatotrichum* and has revealed *S. manabiense* to be a distinct species.

J. Bot. Res. Inst. Texas 3(2): 503 – 510. 2009

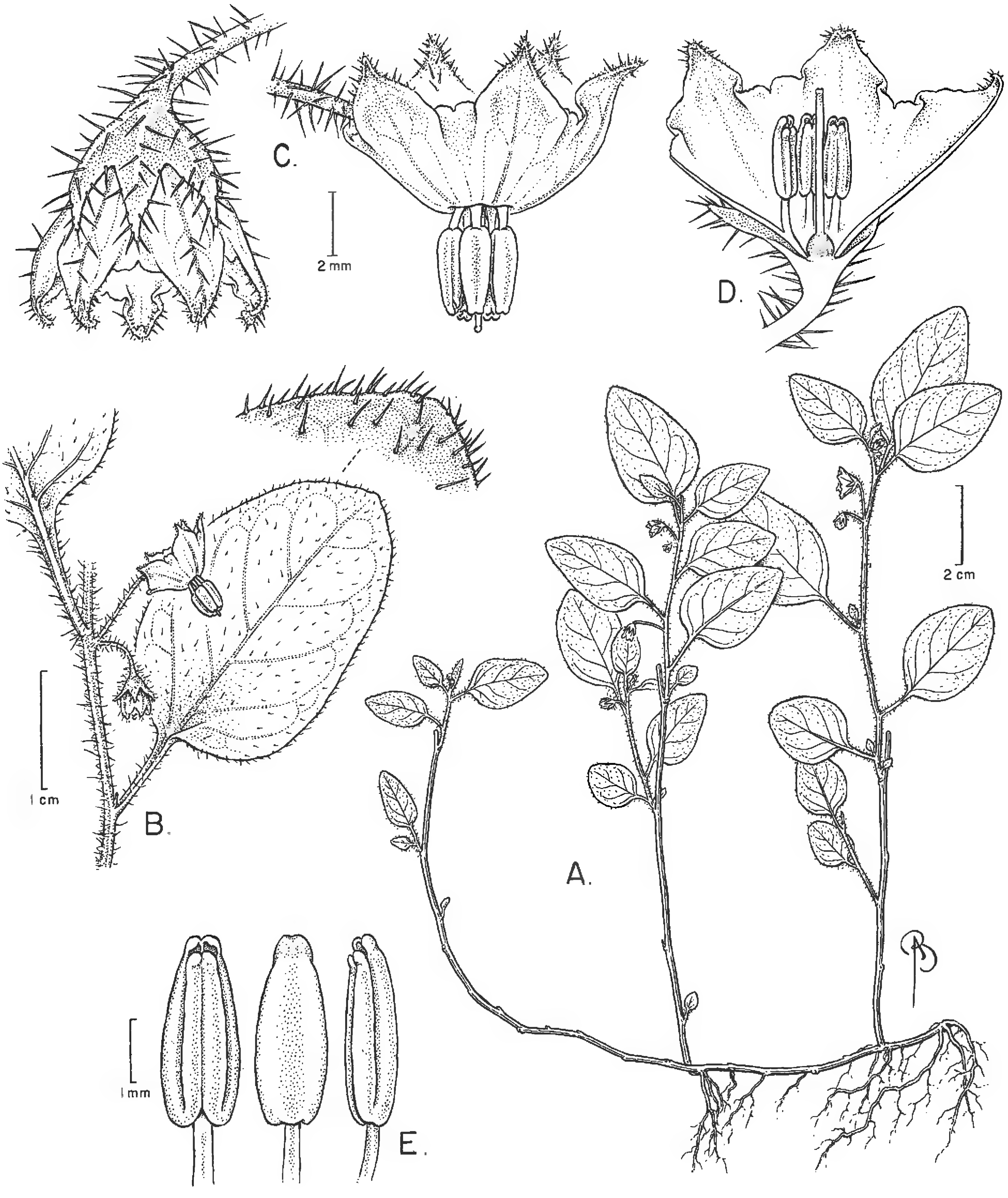


Fig. 1. ***Solanum manabiense*** **S. Stern. A, B. Habit. C. Bud (left) and opened flower (right). D. Flower cross section. E. Stamens. All from** ***T. Plowman & P. Alcorn 14334*** **(NY)**

Solanum manabiense S. Stern, sp. nov. (**Figs. 1–2**). Type: ECUADOR. Manabí: Pacoche Reserve, road from Manta to San Lorenzo, ~2 km W of El Aromo, 01°04'09.5"S, 80°52'32"W, 350 m, 8 Feb 2009 (fl, fr), *S. Stern & E.J. Tepe 377* (holotype: QCNE; isotypes: BM, F, MO, NY, QCA, UT).

Solano deflexo et *S. hoffmanseggii* affinis sed a *S. deflexo* habitu rhizomatoso et seminibus sine margine tumido et incisum apicali, a *S. hoffmanseggii* pilis non geniculatus differt.

Rhizomatous herb, sometimes slightly woody at the base, 1.5–4 dm tall. Stems sparsely to densely pubescent

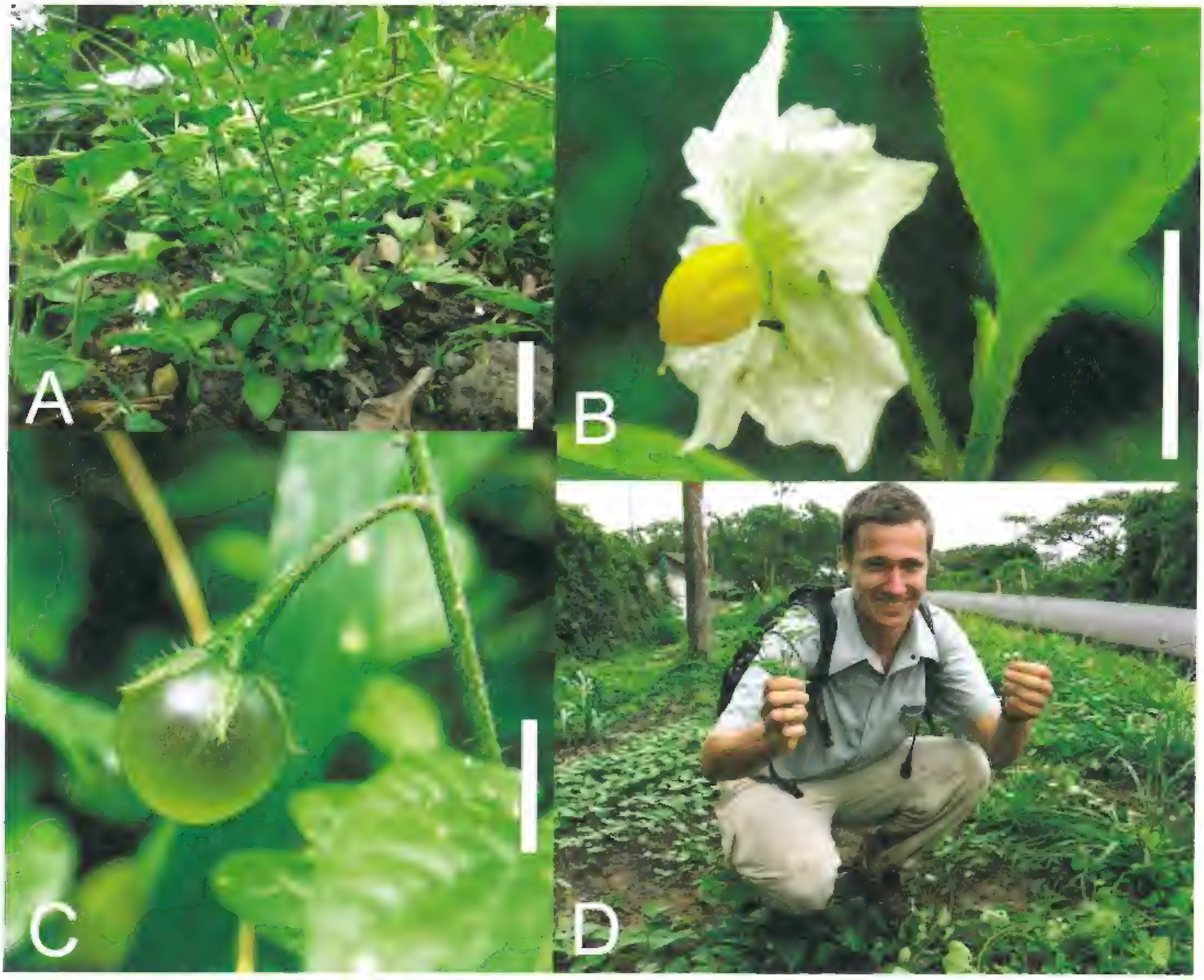


Fig. 2. Photos of type collection of *Solanum manabiense* S. Stern. A. Habit. B. Flower; note hairs on stem and leaves. C. Fruit, with skin becoming transparent as water pressure increases. D. Roadside habitat in Manabí, Ecuador and author with type collection. Scale lines A = 10 cm. B, C = 5 mm.

with two celled unbranched, straight hairs, unarmed. Sympodial units difoliate, geminate. Leaves simple, 1–6 × 0.5–3 cm, elliptic to elliptic-ovoid, chartaceous to membranaceous, nearly glabrous to sparsely pubescent adaxially and abaxially with one- to two-celled, unbranched, straight hairs, these lying flat along the blade, denser along veins; base rounded to obtuse, often decurrent into petiole; margin entire and ciliate with unbranched hairs; apex acute to obtuse; petioles 0.5–1 cm, moderately pubescent with unbranched straight hairs. Inflorescence sessile, extra-axillary or subopposite the leaves, unbranched, with 1–5 flowers, all flowers perfect, the axes sparsely to moderately pubescent with unbranched hairs; peduncle absent; rachis absent to ca. 1 mm; pedicels 5–15 mm in flower, 10–20 mm in fruit, nearly contiguous, articulated at the base. Flowers homostylous, 5-merous. Calyx 3–10 mm long, the tube 1–3 mm, the lobes 2–7 × 0.5–1.5 mm, linear-lanceolate, moderately to densely pubescent; fruiting calyx not accrescent, not completely covering the fruit. Corolla 0.4–1 cm in diameter, 2–3 mm long, rotate with abundant interpetalar tissue, chartaceous to membranaceous, white, the tube 2–3 mm long, the lobes very short, 1–2 × 0.5–1 mm, triangular, acute at apices, sparsely to moderately pubescent abaxially and on margin with 2–3-celled unbranched, straight hairs, glabrous adaxially. Stamens 2–4 mm long; filaments up to 1 mm long, glabrous; anthers 1.5–3 × 0.5–1.5 mm, oblong, connivent, yellow, the base cordate, the apex emarginate, the pores directed introsely and subapically, not opening into longitudinal slits. Ovary glabrous; style 4–6 × 0.5–1 mm, equal to or exserted beyond stamens, cylindrical, glabrous; stigma up to 1 mm wide, capitate. Fruit a globose berry, 5–12 mm in diameter, white to yellow when immature, maturing semitransparent, drying brown, glabrous, the mesocarp watery and held under pressure until dehiscing explosively at maturity. Seeds 10–35 per fruit, ca. 2.5 × 1.5 mm, somewhat flattened, with a small notch where connected to placenta, the margin not swollen, the surface with fine raised ridges radiating from the center to the edges and shallow ridges running parallel to margin.

Distribution and phenology.—Known only from the central coast of Ecuador in Provs. Manabí and Guayas from sea level to 400 m. Flowering and fruiting specimens have been collected in February and July.

Solanum manabiense is unique in section *Gonatotrichum* due to the combination of its rhizomatous habit; difoliate, occasionally geminate sympodia; leaves glabrous on the abaxial surface; unbranched, straight (non-geniculate) hairs; small flowers with equal stamens; and seeds with unexpanded margins and no obvious notch at the attachment point to the placenta. It is apparently restricted to coastal Ecuador in the Guayas and Manabí provinces. It is named for the latter province where the type was found and the species is apparently a common roadside weed.

Solanum manabiense resembles *S. hoffmanseggii*, but the hairs of *S. hoffmanseggii* are geniculate whereas those of *S. manabiense* are straight. *Solanum manabiense* also resembles *S. turneroides*, but *S. turneroides* is a more robust herb with heterantherous flowers that are much larger than those of *S. manabiense*. *Solanum manabiense* is also similar to *S. deflexum*, but the latter has densely pubescent leaves, is not rhizomatous, and has seeds with a swollen margin and pronounced notch where they connect to the placenta.

Parsimony analyses of sequence data from three molecular markers (nuclear *waxy* or GBSSI and ITS and chloroplast *trnT-F*) place *Solanum manabiense* in the *Gonatotrichum* clade (S. Stern, unpub. data). The *waxy* and combined analyses place *S. manabiense* sister to a clade containing the South American species *S. hoffmanseggii* and *S. turneroides*. The Central American *S. deflexum* and *S. lignescens* clade is more distantly related. *Solanum manabiense* is the only species of *S.* section *Gonatotrichum* known from northern South America.

PARATYPES: **ECUADOR. Guayas:** 2 to 4 km E from Recinto Olon, ca. 10 km N of Manglaralto, 19 Feb 1974, *Gentry 10068* (MO). **Manabí:** Montecristi, Cerro Montecristi, eastern slopes above town, 18 Jul 1986, *Plowman & Alcorn 14334* (F, NY, QCA).

The second new species, *Solanum zumbense*, belongs to the Cyphomandra clade of *Solanum* along with other species traditionally recognized in *S.* sections *Pachyphylla* and *Cyphomandropsis* Bitter (Bohs 2005, 2007). Many members of this clade were formerly segregated as the genus *Cyphomandra* due to their enlarged anther connectives, which function as osmophores for the attraction of male euglossine bees (Bohs 1994). Subsequent phylogenetic research revealed that *Cyphomandra* is deeply nested within *Solanum*, necessitating the transfer of all of its species to *Solanum* (Bohs 1995). Monophyly of the group of species with enlarged anther connectives has not been conclusively demonstrated, but monophyly of the more inclusive group of species comprising the Cyphomandra clade is well-supported (Bohs 2005, 2007; Weese & Bohs 2007).

Monographs have been published for species of the Cyphomandra clade (Bohs 1994, 2001), but novelties continue to be discovered. Specimens of the following new species were annotated as *S.* sp. aff. *obliquum* or *S.* sp. nov. by Bohs during the preparation of her 1994 treatment. Some collections recognized here as *S. zumbense* were noted in the monograph as being anomalous within *S. obliquum* Ruiz & Pav., but at that time there was some doubt about their status as a distinct species. Subsequent assessment of herbarium and living material confirm that these collections represent a new species.

Solanum zumbense Bohs, sp. nov. (**Fig. 3**). TYPE: ECUADOR. ZAMORA-CHINCHIPE: road between Zumba and Amaluza, 8–10 km W of Zumba, 04°50'07"S, 79°09'50"W, 1500–1700 m, 31 Mar 2005 (fl, fr), *L. Bohs et al. 3366* (HOLOTYPE: QCNE; ISOTYPES: BM, LOJA, NY, QCA, UT).

Solano obliquo simile sed corollis purpurascibus filmentis longis et fructibus acutis differt.

Shrub or small tree 1–3 m tall, from a single trunk with a spreading crown. Stems densely puberulent with unbranched glandular and eglandular hairs and often also sparsely to moderately pilose with eglandular hairs 1–3 mm long. Sympodial units 3–4-foliate, geminate or not. Leaves simple, the blades 4–25 × 2.3–24 cm, 1–2.5 times as long as wide, subcoriaceous, ovate, sparsely to densely puberulent adaxially and abaxi-

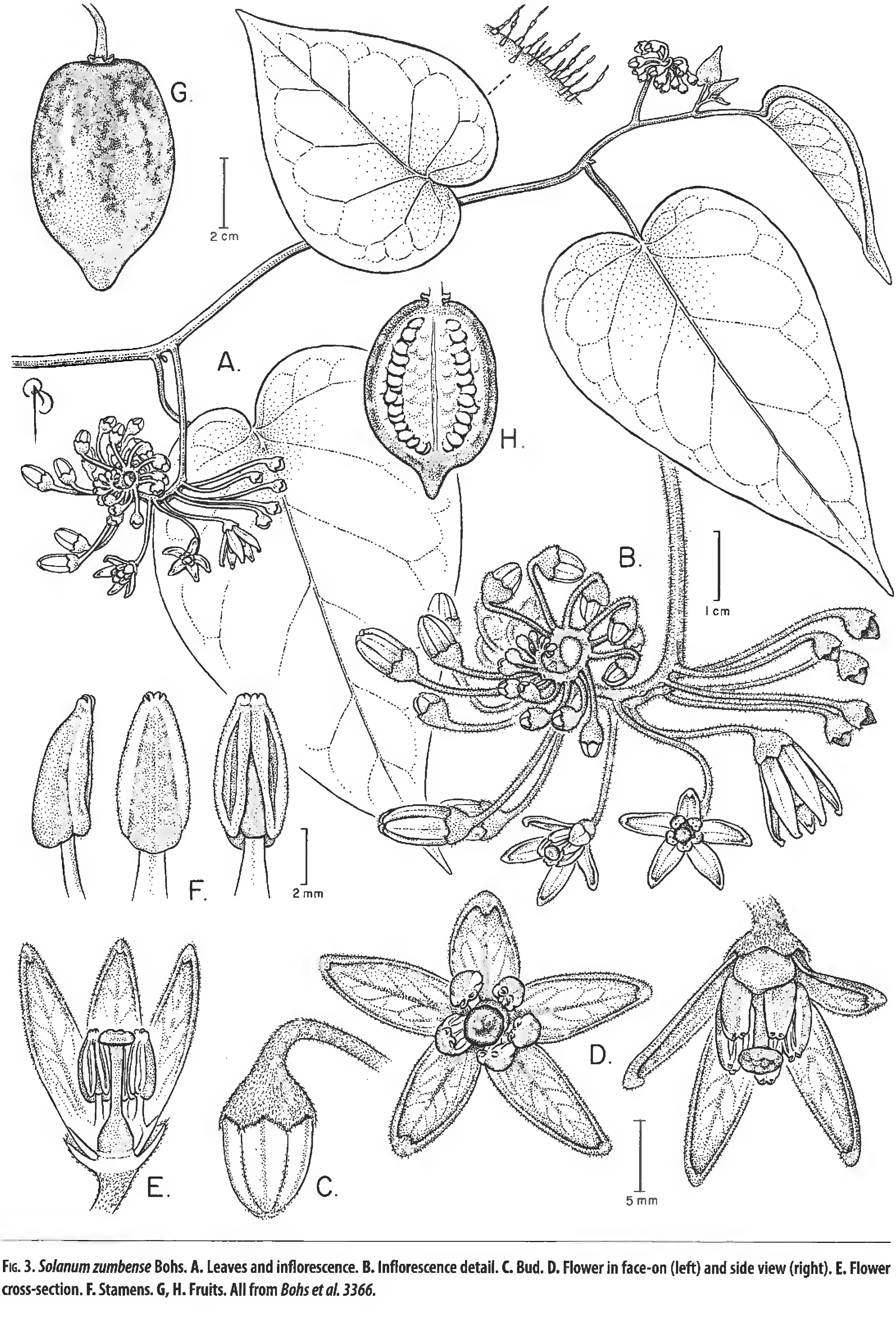


Fig. 3. *Solanum zumbense* Bohs. **A.** Leaves and inflorescence. **B.** Inflorescence detail. **C.** Bud. **D.** Flower in face-on (left) and side view (right). **E.** Flower cross-section. **F.** Stamens. **G, H.** Fruits. All from *Bohs et al. 3366.*

ally with unbranched eglandular hairs and often also sparsely to densely pilose with unbranched hairs 1–3 mm long, the hairs more dense on veins; major veins ca. 5 per side; base truncate to deeply cordate, often oblique, with basal lobes (0–)0.5–3.5 cm; margin entire; apex acuminate; petioles 3–10 cm, densely puberulent and often also sparsely to moderately pilose. Inflorescences 3–12(–25) cm long, leaf-opposed or in a branch fork, unbranched, forked, or rarely further branched, with 15–40 flowers, all flowers perfect, the axes densely puberulent (-pilose); peduncle 1.5–5 cm; rachis 1–6.5 (–20) cm; pedicels 15–25 mm, 25–40 mm in fruit, spaced 1–6 mm apart, articulated near the base and leaving pedicellar remnants ca. 1 mm long. Buds ellipsoidal or ovoid, acute at apex. Flowers homostylous, 5-merous. Calyx 3–5 mm long, the tube 2–4 mm, the lobes 1–2 × 2–3 mm, deltate to very shallow, apiculate at tips, subcoriaceous, moderately to densely puberulent, with hairs denser toward tips of lobes; fruiting calyx not accrescent. Corollas 1.5–2 cm in diameter, 12–16 mm long, stellate, coriaceous, dull greenish, violet, or brownish-purple, the tube 1–2 mm, the lobes 9–14 × 3–4 mm, narrowly triangular, acute and slightly cucullate at apices, glabrous abaxially, glabrous to sparsely puberulent adaxially on midrib and toward apices, the margin tomentose to ciliate. Stamens with the free part of filaments 2–4 mm long, the filament tube 1–2 mm; anther thecae 4–5 × 1.5–2 mm, lanceolate, loosely connivent, cream to purplish, the pores directed abaxially and distally, not opening into longitudinal slits; connective 4–5 × 1.5–2 mm, lanceolate, purple or brownish, abaxially slightly shorter than thecae at apex, slightly exceeding them at base, adaxially produced as a swelling ca. 3 × 1 mm. Ovary glabrous or finely puberulent; style 4–7 × 0.5–1 mm in diameter at base, 1.5–2.5 mm in diameter at apex, equal to or shorter than the stamens, umbrella-shaped, strongly dilated distally, glabrous; stigma truncate, 1.5–2.5 mm in diameter, with two prominent apical glands. Fruits 6–7 × 1.5–4.5 cm, ellipsoidal to fusiform, acute to apiculate at apex, pale yellow when mature, glabrous to finely puberulent; stone cell aggregates large. Seeds 5–6 × 3–4 mm, flattened, reniform, rugulose to pubescent along margin with white pseudohairs.

Distribution and phenology.—Clearings and open places in tropical rain forest, (400–)1500–2255 m in elevation, eastern Andean slopes in southern Ecuador and Peru, with an outlying collection from Brazil. Flowering specimens have been collected in March, July, September, November, and December. Fruiting specimens have been collected in March through June and December.

Local names.—Peru: chupo sacha (*Schunke 5866*); tomato del campo (*Mexia 8235*). Brazil: tsetsepere (Deni; *Prance et al. 16402*).

Uses.—*Mexia 8235* describes the fruits as having a tomato-like taste, and *Bohs et al. 3366* describe them as sweet-sour. In Amazonian Brazil, the leaves are heated in water and used to bathe babies, both to keep them healthy and to cure fever (*Prance et al. 16402*). *Schunke 5866* reports that an infusion is given in an enema to combat the grippe.

Within the Cyphomandra clade, *S. zumbense* is most similar to *S. obliquum*. Both species have very broad stigmas with two apical glands, short anthers with the connective not prolonged below the bases of the anther thecae, and stellate, coriaceous corollas with relatively broad and spreading lobes. *Solanum zumbense* differs from *S. obliquum* in having abundant long hairs on the foliage and axes, pointed and often pubescent fruits, and purplish, nearly glabrous corollas. The filaments are quite long and are a distinctive feature. *Solanum zumbense* is found at higher elevations (above 1500 m) than typical plants of *S. obliquum*.

Solanum zumbense takes its name from the town of Zumba in southern Ecuador near the Peruvian border, where the type collection was made. Although this locality is in the northern extremity of the range of this species, the euphonious epithet was too good to pass up. "Zumbar" is also the Spanish word for "buzz," a common pollination mechanism in many species of *Solanum*.

Paratypes. **ECUADOR. Zamora-Chinchipe:** trail between Mirador and Pallas, 2010–2255 m, 9 Sep 1943 (fl), *Steyermark 54279* (NY). **Peru. Amazonas:** Prov. Amazonas, Dist. Vista Alegre, Sector Romero, ca. 1 km de Vista Alegre, 06°10'S, 77°18'W, 1540–1720 m, 1 Jul 1998 (fl), *Sánchez Vega & Zapata 9595* (F). **Huánuco:** Dist.: Churubamba, trail Puente Durand to Exito, 1625 m, 26 Sep 1936 (fl, fr), *Mexia 8235* (B, BH, BM, F, GH, K, MO, NY, S, U, US); Prov. Leoncio Prado, Dist. Hermilio Valdizán, La Divisoria, 21.8 km E of Puente Pumahuasi (Río Tulumayo) on road from Tingo María to Pucallpa, ca. 09°05'S, 75°52'W, 1550 m, 27 Dec 1981 (fr), *Plowman & Schunke 11724* (F, GH, MO); Agua Blanca (carretera Monzón), 22 Apr 1962 (fr), *Schunke 5866* (F, US); Prov. Huánuco, km 474 on Lima-Tingo

María road, Huánuco, 1650 m, 2 Jun 1981 (fr), *Young & Sullivan 634* (NY). **Pasco:** Oxapampa, ca. 2 km E of village, 10°35'S, 75°35'W, 1850 m, 10 Mar 1984 (fl, fr), *Knapp et al. 6315* (BH, F, G, GH, MO, NY, US); Prov. Oxapampa, 5 km SE of Oxapampa, 75°23'W, 10°36'S, 1850 m, 13–16 Dec 1982 (fl, fr), *D. Smith 2959* (F, NY); Oxapampa Prov., Palcazu valley, Río San José in the Río Chuchurras drainage, 75°20'W, 10°09'S, 400–500 m, 14 May 1983 (fr), *Smith 4023* (NY). **San Martín:** prope Tarapoto, 1855–6, *Spruce 4941* (NY). **Ucayali:** Prov. Coronel Portillo, Cordillera Azul, km 43 on Tingo María-Pucallpa road, ca. 1500 m, 5 Jun 1981 (fr), *Young & Sullivan 741* (MO). **BRAZIL. Amazonas:** basin of the Rio Purus, Rio Cunhuá at Canaçã, 06°34'S, 66°27'W, 27 Nov 1971 (fl), *Prance et al. 16402* (NY).

NEW COMBINATIONS IN *SOLANUM* SECTION *PACHYPHYLLA*

Bohs (1995) transferred the epithets of all *Cyphomandra* species to *Solanum*. However, transfers of infraspecific taxa were not made at that time. The combination *Solanum corymbiflorum* subsp. *mortoniana* (L.B. Sm. & Downs) Bohs was published in Zuloaga et al. (2007) and the citation is included here for completeness. The following new combinations will validate the remaining infraspecific taxa belonging to *S.* sect. *Pachyphylla*.

Solanum circinatum Bohs subsp. **ramosum** (Bohs) Bohs, comb. nov. Basionym: *Cyphomandra hartwegii* (Miers) Walpers subspecies *ramosa* Bohs, Revista Acad. Colomb. Ci. Exact. 16:73. 1988. Type: COLOMBIA. Huila: Fundación Merenberg, ca. 1300 m, 18 Aug 1981 (fl, fr), *L. Bohs 1644* (holotype: COL; isotypes: CAUP, GH).

Solanum corymbiflorum (Sendtn.) Bohs subsp. **mortonianum** (L.B. Sm. & Downs) Bohs, Darwiniana 45:241. 2007 (as "subsp. *mortoniana*"). Basionym: *Cyphomandra mortoniana* L.B. Sm. & Downs, Phytologia 12:250. 1965. *Cyphomandra corymbiflora* Sendtn. subsp. *mortoniana* (L.B. Sm. & Downs) Bohs, Fl. Neotrop. Monogr. 63:68. 1994. Type: BRAZIL. Santa Catarina: São Joaquim, near Mantiqueira (27 km E of São Joaquim), 1100–1200 m, 16 Jan 1957, *L.B. Smith & R. Reitz 10219* (holotype: US; isotypes: GH, HBR, R).

Solanum diversifolium Dunal subsp. **chloranthum** (Rusby) Bohs, comb. nov. Basionym: *Cyphomandra chlorantha* Rusby, Descr. S. Amer. Pl. 116. 1920. *Cyphomandra diversifolia* (Dunal) Bitter subspecies *chlorantha* (Rusby) Bohs, Fl. Neotrop. Monogr. 63:82. 1994. Type: COLOMBIA. Santa Marta: Valparaiso, rare in damp clearings, flowers Jan to Apr, 4500 ft, 26 Jan–25 Feb 1899 (fl, fr), *H.H. Smith 1180* (lectotype, designated by Bohs 1994: NY; isolectotypes, A, F, G, GH, K, L, LL, MO, NY, P, S, U, US, W, WIS).

Solanum endopogon (Bitter) Bohs subsp. **guianense** (Bohs) Bohs, comb. nov. Basionym: *Cyphomandra endopogon* Bitter subspecies *guianensis* Bohs, Fl. Neotrop. Monogr. 63:90. 1994. Type: FRENCH GUIANA. Saul, Monts La Fumée, 3°37'N, 53°12'W, 200–400 m elev., 16 Aug 1982 (fl), *S. Mori & B. Boom 14709* (holotype: F).

In addition to validating these infraspecific names, molecular evidence in Bohs (2007) indicates that *S. circinatum* subsp. *ramosum* might be better recognized as a distinct species. The combination *S. ramosum* Lam. has already been published; therefore a new epithet must be coined for this taxon. The epithet *huilense* commemorates the predominant distribution of the plants, in Dept. Huila, Colombia.

Solanum huilense Bohs, nom. nov. for *Solanum circinatum* Bohs subsp. *ramosum* (Bohs) Bohs. Basionym: *Cyphomandra hartwegii* (Miers) Walpers subsp. *ramosa* Bohs, Rev. Acad. Colomb. Ci. Exact. 16:73. 1988. Type: COLOMBIA. Huila: Fundación Merenberg, ca. 1300 m, 18 Aug 1981 (fl, fr), *L. Bohs 1644* (holotype: COL; isotypes: CAUP, GH).

ACKNOWLEDGMENTS

We thank J. Bennett, J. Clark, and E. Tepe for field assistance; the herbaria listed for loans of specimens; and Bobbi Angell for the drawings. This work was supported by NSF grant DEB-0316614 (PBI *Solanum*: A Worldwide Treatment) to LB. Gregory J. Anderson and an anonymous reviewer provided critical reviews.

REFERENCES

Bohs, L. 1994. *Cyphomandra* (Solanaceae). Fl. Neotrop. Monogr. 63, New York Botanical Garden, Bronx, New York.

Bohs, L. 1995. Transfer of *Cyphomandra* (Solanaceae) and its species to *Solanum*. Taxon 44:583–587.

Bohs, L. 2001. A revision of *Solanum* section *Cyphomandropsis* (Solanaceae). Syst. Bot. Monogr. 61:1–83.

Bohs, L. 2005. Major clades in *Solanum* based on *ndh*F sequence data. In: Keating, R.C., V.C. Hollowell, and T.B. Croat, eds. A festschrift for William G. D'Arcy: the legacy of a taxonomist. Monogr. Syst. Bot. Missouri Bot. Gard., Vol. 104. Missouri Botanical Garden Press, St. Louis, Missouri. Pp. 27–49.

Bohs, L. 2007. Phylogeny of the *Cyphomandra* clade of the genus *Solanum* (Solanaceae) based on ITS sequence data. Taxon 56:1012–1026.

Knapp, S., L. Bohs, M. Nee, and D.M. Spooner. 2004. Solanaceae – a model for linking genomics with biodiversity. Comp. Funct. Genomics 5:285–291.

Nee, M. 1989. Notes on *Solanum* section *Gonatotrichum*. Solanac. Newsl. 3:80–82.

Weese, T.L. and L. Bohs. 2007. A three gene phylogeny of the genus *Solanum* (Solanaceae). Syst. Bot. 32:445–463.

Zuloaga, F.O., O. Morrone, and M.J. Belgrano. 2007. Novedades taxonómicas y nomenclaturales para la flora vascular del Cono Sur de Sudamérica. Darwiniana 45:236–241.

THREE NEW SPECIES OF *SOLANUM* SECTION *HERPYSTICHUM* (SOLANACEAE) FROM ECUADOR

Eric J. Tepe and Lynn Bohs

Department of Biology, 257 S. 1400 E.
Salt Lake City, Utah 84112, U.S.A.
Author for correspondence: eric.tepe@ utah.edu

ABSTRACT

Three new species of *Solanum* sect. *Herpystichum* from Ecuador are described and illustrated: **S. limoncochaense,** endemic to the lowlands of eastern Ecuador, **S. pacificum,** endemic to the Pacific lowlands, and **S. crassinervium,** from northwestern Ecuador and southwestern Colombia. *Solanum limoncochaense* resembles the Colombian species *S. dalibardiforme*, but differs primarily in having stellate corollas. *Solanum pacificum* is similar to *S. dolichorhachis*, but has very thin, symmetrical leaves rather than chartaceous to coriaceous leaves with markedly oblique bases. Lastly, *S. crassinervium* is most similar to *S. evolvulifolium*, but can be differentiated by its larger, somewhat fleshy leaves with prominent veins. *Solanum limoncochaense* and *S. pacificum* are both apparently restricted to small reserves and are believed to be in critical danger of extinction.

RESUMEN

Tres especies nuevas de *Solanum* sección *Herpystichum* del Ecuador son descritas e ilustradas: **S. limoncochaense,** endémica a las tierras bajas del Ecuador oriental, **S. pacificum,** endémica de las tierras bajas del Ecuador occidental, y **S. crassinervium,** del noroeste del Ecuador y el suroeste de Colombia. *Solanum limoncochaense* guarda semejanza con la especie colombiana *S. dalibardiforme*, de la cual se distingue por sus corolas esteladas. *Solanum pacificum* se asemeja a *S. dolichorhachis*, pero tiene hojas muy finas y simétricas en vez de hojas de cartáceas a coriáceas con las bases claramente oblicuas. Finalmente, *S. crassinervium* se parece a *S. evolvulifolium*, pero se puede diferenciar por las hojas más grandes y algo carnosas con nervaduras prominentes. Las distribuciones de *S. limoncochaense* y *S. pacificum* están restringidas a reservas pequeñas y se creen en peligro grave de extinción.

INTRODUCTION

The genus *Solanum* has been the focus of intense research because it contains several important crop species, including the potato (*S. tuberosum*), tomato (*S. lycopersicum*), and eggplant (*S. melongena*). Despite the economic importance of the genus, however, many groups among its ca. 1500 species remain poorly known. The "PBI *Solanum*: a world-wide treatment" project (www.solanaceaesource.org), an NSF-funded initiative to provide online descriptions and keys to all *Solanum* taxa, has allowed for increased exploration and discovery of new *Solanum* species. Ecuador is home to 183 species of *Solanum*, including 31–34 endemics, and is one of the highest centers of diversity for the genus (Jørgensen & León-Yánes 1999; Montúfar 2000). This paper, along with three others funded by this project (Knapp 2007, 2008; Stern & Bohs 2009), adds seven new species, five of which are endemic, to the list of Ecuadorian *Solanum*.

Solanum sect. *Herpystichum* Bitter is a group of ca. ten species found from Central America to northern Peru, and is a member of the informally-named "Potato clade" (Weese & Bohs 2007). Molecular phylogenetic analyses indicate that sect. *Herpystichum* constitutes a monophyletic group sister to sect. *Pteroidea* Dunal (Weese & Bohs 2007; Tepe & Bohs, unpublished manuscript). Species of sect. *Herpystichum* are trailing, terrestrial or climbing, herbaceous to woody vines rooting at the nodes. They are primarily plants of the rainforest understory, but several species are also found in pastures or other open areas. Like sect. *Pteroidea*, they have perfect flowers, but can be distinguished by the usually extra-axillary inflorescences (those in sect. *Pteroidea* are axillary in position). Some species have flattened fruits that are unique in *Solanum*. This group has never been revised and has received little attention since Bitter described most of its species in 1912 and 1913 (Bitter 1912, 1913a, b). Detailed study of sect. *Herpystichum* has revealed three additional species, described herein, that have been collected since Bitter's focus on the genus. Two of the species are endemic

J. Bot. Res. Inst. Texas 3(2): 511 – 519. 2009

to Ecuador and occur in small reserves in areas under intense pressure from large-scale agricultural or oil exploration. They should both be added to the Red List for Ecuadorian Endemics (Knapp et al. 2007).

Maximum parsimony analysis of sequence data from nuclear ITS and GBSSI (or *waxy*) sequences place all three species in sect. *Herpystichum* (Tepe & Bohs, unpublished manuscript). *Solanum crassinervium* and *S. pacificum* are in a clade with *S. evolvulifolium* Greenm., a widespread species that occurs from Central America and Andean South America and *S. loxophyllum* Bitter from the Pacific lowlands of Ecuador. *Solanum limoncochaense* is in a clade with the morphologically similar Central American species *S. phaseoloides* Polak. and *S. trifolium* Dunal, a high-elevation species known only from Bolívar Province, Ecuador. We were unable to obtain material for molecular analysis of *S. dalibardiforme* Bitter and *S. dolichorhachis* Bitter, the species most similar morphologically to *S. limoncochaense* and *S. pacificum*, respectively.

Solanum pacificum Tepe, sp. nov. (**Fig. 1**). TYPE. ECUADOR. Los Ríos: Centro Científico Río Palenque, in secondary forest, 215 m, 5 Feb 2009 (fl, fr), *E.J. Tepe et al. 2696* (HOLOTYPE: QCNE!; ISOTYPES: BM!, MO!, NY!, QCA!, UT!).

Solano dolichorhache aemulans, differt omnibus organis glabris, caulibus molliter herbaceis et foliorum basibus symmetricis.

Vine, climbing other vegetation via adventitious roots at the nodes. Stems slender, weakly herbaceous, glabrous, densely gland-dotted; fertile branch tips pendent. Sympodial units plurifoliate, not geminate. Leaves simple, 14–19 × 4.5–8 cm, 2–3 times as long as wide, lanceolate to ovate, membranaceous to thinly chartaceous, glabrous adaxially and abaxially, densely gland-dotted, the base rounded to obtuse, more or less symmetrical, the margin entire, the apex acuminate; petioles 1–1.5 cm, glabrous, densely gland-dotted. Internodes 1.5–7 cm. Inflorescences 4–10 × 2–3 cm, slender, extra-axillary, unbranched with 17–58 flowers (scars), all flowers apparently perfect, the axes glabrous, very slender; peduncle 2–4.5 cm long; rachis ca. 6 cm; pedicels 8–10 mm in flower, slender, 15–20 mm in fruit, enlarged apically, glabrous, spaced nearly contiguously to 12 mm apart, articulated at base. Flowers with the calyx 1–1.2 mm long, glabrous to minutely and sparsely ciliate along margins, the tube 0.5–0.7 mm long, the lobes 0.5–0.6 × 0.8–1 mm, rounded, rounded to weakly acuminate at tips; fruiting calyx somewhat accrescent, the lobes 0.6–0.8 × ca. 1 mm. Corolla 0.8–1 cm in diameter, ca. 5 mm long, stellate, membranous, green to white near the margins of the petals, the lobes 4–5 × 1.2–2.5 mm, reflexed at maturity, acute at apices, glabrous adaxially and abaxially, the margins ciliate. Stamens subequal, with filaments ca. 0.8 mm long, glabrous, free; anthers 1.5–2 × 0.7–1.2 mm, oblong, not connivent, yellow, the pores directed distally, opening into short longitudinal slits with age. Ovary glabrous; style 4–4.5 × 0.1–0.2 mm, glabrous, slightly clavate; stigma truncate. Fruit (immature) ca. 0.9 × 0.6 cm, ovoid, pointed at apex, green, glabrous. Seeds unknown.

Additional specimens examined: **ECUADOR. Junction of the provinces Bolivar, Cañar, Chimborazo, and Guayas:** Foothills of the western cordillera near the village of Bucay, 1000–1250 ft, 8–15 Jun 1945 (st), *W.H. Camp E-3782* (MO). **Los Ríos:** Cantón Quevedo, Centro Científico Río Palenque, along road between Santo Domingo de los Colorados and Quevedo at km 47, 1.7 km S of Patricia Pilar, 0°35'S 79°21'W, 220 m, 9 Apr 1992 (st), *T.B. Croat 73807* (MO); Río Palenque Biological Station, km 56 Rd. Quevedo-Sto. Domingo, 150–220 m, 26 Oct 1974 (st), *C.H. Dodson 5663* (SEL); Río Palenque Biological Station, km 56 Rd. Quevedo-Sto. Domingo, 150–220 m, 7 Aug 1975 (fl), *C.H. Dodson 5933* (AAU, MO, QCA, SEL); Río Palenque Field Station, half way between Quevedo and Santo Domingo de los Colorados, 200 m, 22 Feb 1974 (fl), *A. Gentry 10109* (MO).

Solanum pacificum is a striking species with leaves that are deep purplish-green above with whitish veins, and weakly to intensely purple below. This species is apparently quite rare and has not been collected extensively, but it is clearly distinct from other members of sect. *Herpystichum*. It is recognizable by its climbing habit, completely glabrous vegetative parts, its large, very thin leaves and slender, weakly herbaceous stems.

Solanum pacificum specimens have been identified as *S. dolichorhachis*, but *S. dolichorhachis* has wiry woody stems, chartaceous to coriaceous leaves with distinctly oblique leaf bases, and spindle-shaped fruits 2–3 times longer than wide vs. the weak-herbaceous stems, membranaceous leaves more or less symmetrical at the base, and globose to somewhat conical (but less than twice as long as wide) fruits of *S. pacificum*. It is also related to *S. crassinervium*, *S. evolvulifolium*, and *S. loxophyllum*, but is easily distinguished from these species by the texture, shape, and size of the leaves. *Solanum pacificum* also bears a resemblance to the sympatric *S. leptorhachis* Bitter (sect. *Geminata*) due to its simple leaves, long, slender inflorescences, and small,

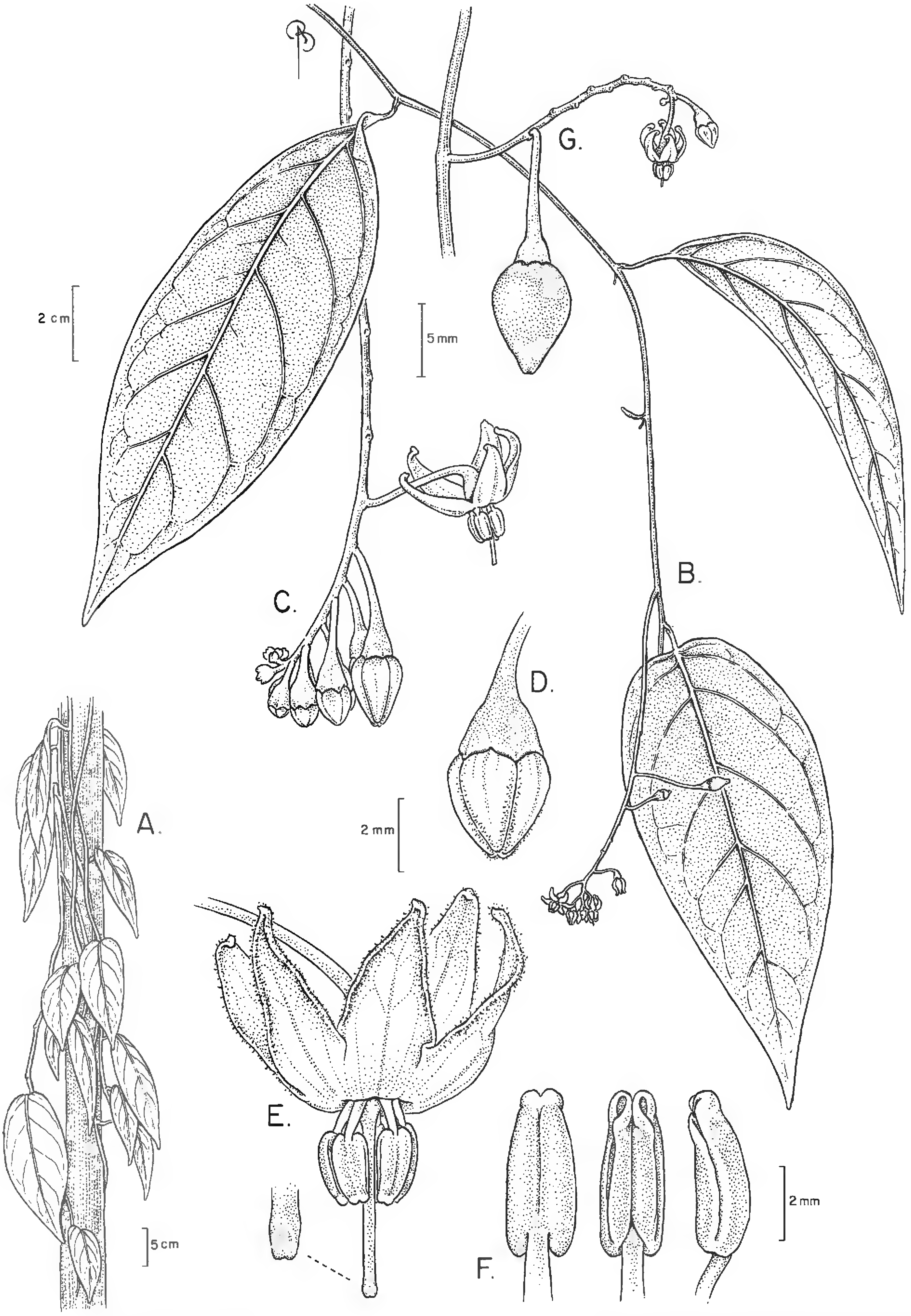


Fig. 1. *Solanum pacificum* Tepe. **A.** Habit. **B.** Leaves and inflorescence. **C.** Inflorescence. **D.** Bud. **E.** Flower and detail of stigma. **F.** Stamens. **G.** Inflorescence with fruit (immature). (All drawn from *E.J. Tepe 2696* [photo & NY]).

stellate, greenish-white flowers. However, *S. leptorhachis* is a free-standing shrub 1–2 m tall with unifoliate sympodial units on flowering stems vs. a vine with plurifoliate sympodial units in *S. pacificum*.

The lowlands of Ecuador between the Pacific Ocean and the Andes are under large-scale cultivation of cacao, papayas, bananas, African oil palm, etc., and very few areas of undisturbed habitat remain intact. Most collections of *S. pacificum* are from the small, but well-preserved Centro Científico Río Palenque reserve. There are no large reserves in western Ecuador (like Yasuní in the east) and it is likely that *S. pacificum* and other plant species endemic to western Ecuador are surviving in small, isolated reserves. As a result, *S. pacificum* is in critical danger of extinction due to habitat loss and every effort should be made to maintain the reserves in this region.

Etymology.—Solanum pacificum is named after the Pacific lowlands of Ecuador where it is endemic, and as a tribute to ET's wife and frequent field companion María Paz Moreno.

Habitat and Distribution.—Solanum pacificum occurs in rainforest habitats in the Pacific lowlands of Ecuador, 50–300 m in elevation.

Phenology.—Flowering specimens have been collected from Feb–Aug; the type collection, collected in Feb, is the only fruiting specimen seen. It is likely that fruiting is more frequent than the collection record indicates.

Solanum crassinervium Tepe, sp. nov. (**Fig. 2**). TYPE. ECUADOR. CARCHI/ESMERALDAS: near Lita, 600 m, wet evergreen forest, 19 May 1987 (fl, fr), *H.H. van der Werff 9496* (HOLOTYPE: QCNE!; ISOTYPES: MO!, NY!).

Solano evolvulifolio affinis sed foliis et floribus majoribus, foliarum nervis lateralibus conspicuis, et petiolis plerumque ultra 5 mm longis notabilis.

Vine or scandent shrub, climbing understory trees as high as 4 m via adventitious roots at the nodes; leafy branches spreading to pendulous. Stems thickly herbaceous to weakly woody, somewhat fleshy, glabrous to very sparsely pubescent and soon glabrescent. Sympodial units plurifoliate to rarely unifoliate, not geminate. Leaves simple, 3.5–14 × 1.5–8 cm, ca. 1–2 times as long as wide, gradually reduced in size toward the inflorescence, ovate to elliptic, somewhat fleshy, glabrous adaxially and abaxially, the secondary veins 5–7 per side, conspicuous and prominent abaxially, the base rounded to truncate to cordate, sometimes oblique, the margin entire, the apex shortly acuminate; petioles (0.2–)1–1.5 cm, glabrous. Internodes 1.5–5.5 cm. Inflorescences 1–3 × 1–4 cm to ca. 6 × ca. 5.5 cm in fruit, stem-terminal to axillary to extra-axillary, unbranched to branched, with 2–16 flowers (scars), all flowers apparently perfect, the axes glabrous; peduncle 0.1–0.5 cm long; rachis 0.1–2 cm; pedicels 4–12 mm in flower, 9–18 mm in fruit, only slightly enlarged apically, glabrous to rarely very sparsely pubescent, spaced nearly contiguously, articulated at base. Flowers with the calyx 2.5–3.5 mm long, glabrous, the margins thickened, the tube 2.5–3 mm long, the lobes 1.5–2.5 × 1.5–2 mm, deltoid, acute to acuminate at tips, white to pale pink; fruiting calyx somewhat accrescent, the lobes 1.5–2 × 1.5–2.5 mm. Corolla 1.5–2 cm in diameter, 5–8 mm long, stellate, somewhat fleshy, white, the lobes 5–8 × 2.5–3 mm, planar at anthesis, acute to acuminate at apices, glabrous adaxially, sparsely pubescent near the apex abaxially, the margins densely ciliate. Stamens equal, with filaments 1–1.5 mm long, glabrous, free; anthers 3–4 × 1.2–1.5 mm, oblong, not connivent, yellow, the pores directed distally, opening into short longitudinal slits with age. Ovary glabrous; style 4–6 × ca. 0.3 mm, glabrous, cylindrical, sometimes deflected to one side of flower (Fig. 1D); stigma capitate. Fruit (immature) 0.7–1 × 0.7–0.9 cm, ovoid to nearly globose, slightly flattened, somewhat pointed at apex, green to pale orangish to brownish at maturity, glabrous. Seeds 2–2.2 × 1.8–2 mm, flattened-reniform, tan, the surface minutely reticulate-rugulose.

Additional specimens examined: **COLOMBIA. Nariño:** Mpio. Barbacoas, Corregimiento Altaquer, Vereda El Barro, Reserva Natural Río Ñambí, margen derecha del Río Ñambí, 1°18'N, 78°08'W, 1325 m, 1 Dec 1993 (fl), *P. Franco et al. 4707* (NY); Mpio. Tumaco, Resguardo de Albí, lado izquierdo del Río Albí, 1°22'N, 78°28'W, 220–280 m, 12 Nov 1995 (fl, fr), *B.R. Ramírez et al. 8826* (NY); Mpio. Barbacoas, Resguardo Indígena de Saundé, 1°30'N, 78°20'W, 350 m, 21 Jan 1996 (fr), *B.R. Ramírez et al. 9699* (NY). **ECUADOR. Carchi:** Cantón Tulcán, Parroquia Tobar Donoso, Reserva Indígena Awá, Centro El Baboso, 0°53'N, 78°25'W, 1800 m, 17–27 Aug 1992 (fr), *G. Tipaz et al. 1813* (BM, NY, QCNE); border area between Prov. Carchi and Esmeraldas, 20 km past Lita on road Lita-Alto Tambo, 550 m, 25 Jun 1991 (fl), *H. van der Werff et al. 11972* (MO, NY, QCNE). **Esmeraldas:** Bilsa Biological Station, Montañas de Mache, 20 km NW of Quinindé, 3 km W of Santa Isabel, 0°22'N 79°45'W, 600 m, 26 Sep 1994 (fr), *J.R. Abbott 15256* (MO); San Lorenzo, Reserva Étnica Awá,

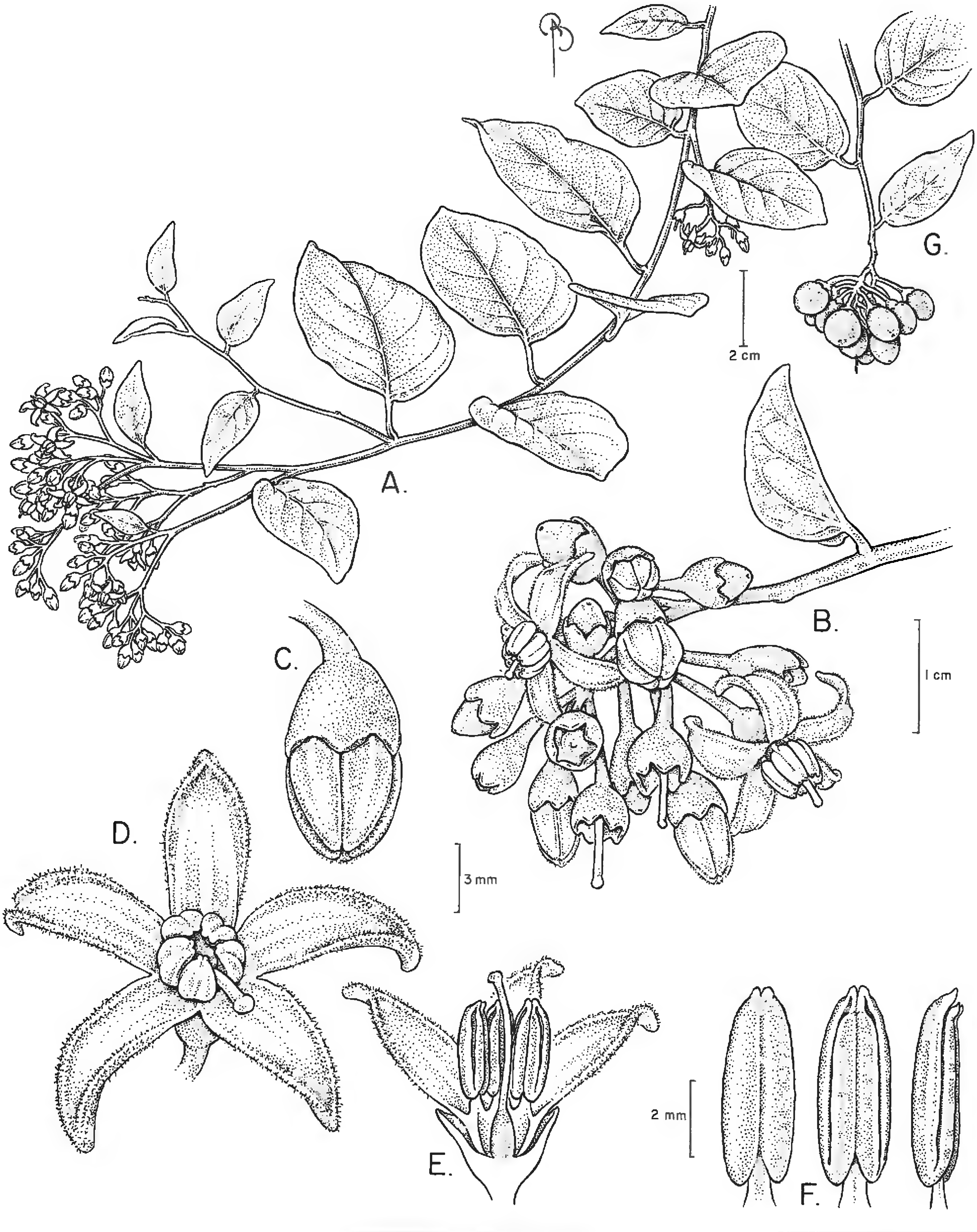


Fig. 2. ***Solanum crassinervium*** **Tepe. A. Habit. B. Inflorescence. C. Bud. D. Flower. E. Flower, longitudinal section. F. Stamens. G. Infructescence (fruits immature). (A, C, E-F drawn from *H. van der Werff 11972* [MO] and *E.J. Tepe 2729* [photo]; B drawn from *E.J. Tepe 2729* [photo]; D drawn from *S. Stern 400* [photo]; G drawn from *G. Tipaz 1813* [MO] and *E.J. Tepe 2729* [photo].**

Parroquia Alto Tambo, Centro de la Union, Cañon del Río Mira, 0°52'N 78°26'W, 250 m, 22 Mar 1993 (fl), *C. Aulestia & M. Aulestia 1431* (QCNE); Cantón Quinindé, Bilsa Biological Station, Montañas de Mache, 35 km W of Quinindé, 5 km W of Santa Isabel, reserve boundary N from Station road, between the Río Cube tributary and the E-bearing boundary crossing the Río Cube, 0°21'N, 79°44'W, 400–600 m, 26 Sep 1994 (fr), *M.S. Bass & N. Pitman 68* (BM, NY); Bilsa Biological Station, Montañas de Mache, 35 km W of Quinindé, 5 km W of Santa Isabel, 0°21'N 79°44'W, 400–600 m, 6 Dec 1994 (fl), *M.S. Bass & N. Pitman 289* (MO); San José, km 321 along railroad from Ibarra to San Lorenzo, 1°N, 78°W, 350 m, 5 May 1982 (fl), *B.M. Boom 1374* (NY, QCA); Cantón Quinindé, Bilsa Biological Station, Montañas de Mache, 35 km W of Quinindé, 5 km W of Santa Isabel, Monkey Bone Trail, 0°21'N, 79°44'W, 400–600 m, 15 Sep 1994 (fr), *J.L. Clark & B. Adnepos 55* (QCNE); Cantón Quinindé, Bilsa Biological Station, Mache Mountains, 35 km W of Quinindé, 5 km W of Santa Isabel, 0°21'N, 79°44'W, 400–600 m, 24 Jan 1995 (fl), *J.L. Clark 412* (BM, NY, QCNE); Cantón Quinindé, Bilsa Biological Station, Mache Mountains, 35 km W of Quinindé, 5 km W of Santa Isabel, 0°21'N, 79°44'W, 500 m, 18 Feb 1996 (fr), *J.L. Clark 2121* (BM, NY, QCNE); Cantón Quinindé, Mache-Chindul Ecological Reserve, Bilsa Biological Station, Mache Mountains, 35 km W of Quinindé, 0°21'N, 79°44'W, 500 m, 1–10 Jan 1997 (fr), *J.L. Clark et al. 3762* (MO, NY, QCNE); 10 km W of Lita on road to San Lorenzo, 0°55'N, 78°30'W, 800 m, 12 May 1991 (fl), *A. Gentry et al. 69984* (MO, NY); Cantón San Lorenzo, Lita to El Cristal road, finca of Dr. La Lama, 13.5 km S of Lita, 0°49'N, 78°26'W, 1220–1350 m, 2 Nov 1992 (fl, fr), *J.L. Luteyn et al. 14744* (MO, NY, QCA); Cantón Quinindé, carretera Herrera–El Páramo (Sat. Isabel), Estación Biológica Bilsa, 0°1'36.7"W, 79°42'40.4"W, 580 m, 18 Feb–5 Mar 1995 (fr), *W. Palacios et al. 13548* (MO, NY, QCNE); Cantón Quinindé, Bilsa Biological Station, Montañas de Mache, 35 km W of Quinindé, 5 km W of Santa Isabela, Monkey Bone trail, 0°21'N, 79°44'W, 400–600 m, 11 Dec 1994 (fl), *N. Pitman & M. Bass 1091* (MO, NY, QCNE); San Lorenzo, Territorio Awá, centro Mataje, 1°11'44"N, 78°34'29"W, 200 m, 17 Nov 2000 (fl), *W. Ramírez et al. 12* (NY), *15* (NY); Bilsa Biological Station, 5 km W of Sta. Isabel, 0°20'49"N 79°42'41"W, 540 m, 14 Feb 2009 (fl, fr), *S. Stern 400* (QCNE, UT); Bilsa Biological Station, 5 km W of Sta. Isabel, 0°20'49"N 79°42'41"W, 540 m, 13 Feb 2009 (fl, fr), *E.J. Tepe & S. Stern 2729* (BM, NY, QCA, QCNE, UT).

Solanum crassinervium is the most robust species in sect. *Herpystichum* and is recognizable by the somewhat fleshy texture of the leaves, stems, and flowers, its ovate to elliptical leaves with conspicuous secondary veins in fresh and dried material, and occasionally branched inflorescences. Its distribution is restricted to the Chocó region of SW Colombia and NW Ecuador, a biodiversity hotspot with one of the highest species diversities per area (Myers et al. 2000), but it is apparently quite common in some parts of its range.

Solanum crassinervium is closely related to *S. evolvulifolium* and *S. loxophyllum*, but differs from both species in its robust habit, ovate leaves (vs. mostly oblong), fleshy calyx and corolla, and inflorescences that may be simple and branched within an individual. The leaves, petioles, and internodes are many times larger than those of *S. evolvulifolium*. *Solanum loxophyllum* is larger in stature than *S. evolvulifolium*, but *S. crassinervium* is easily distinguished from the former based on leaf and inflorescence characters. The leaves of *S. crassinervium*, like those of *S. loxophyllum*, are somewhat fleshy, but *S. crassinervium* has more secondary veins (5–7 vs. 3–4 pairs) and these are prominent abaxially, whereas those of *S. loxophyllum* are obscure within the fleshy leaf blade. These leaf characters are apparent in both fresh and dried material. The often stout inflorescences of *S. crassinervium* differ from those of *S. loxophyllum*, which are apparently always simple and very slender and delicate. Furthermore, inflorescences of *S. loxophyllum* are typically borne on older, leafless parts of the stem, as compared to those of *S. crassinervium*, which appear to always be produced in the leafy parts of the stem. *Solanum crassinervium* has sometimes been identified as *S. siphonobasis* Bitter, a member of *Solanum* sect. *Anarrhichomenum* Bitter, but differs from this species in having > 2 flowers per inflorescence (*S. siphonobasis* has 1–2 flowers per inflorescence), and in the fleshy texture of the leaves, stems, and flowers. Species of sect. *Anarrhichomenum* are also node-rooting vines, but they differ from sect. *Herpystichum* primarily in possessing pseudostipules at the base of the petioles (Correll 1962).

Etymology.—The epithet *crassinervium* describes the prominent secondary veins that help distinguish this species from its closest relatives.

Habitat and Distribution.—*Solanum crassinervium* occurs in lowland and premontane rainforest habitats in the Chocó region of Colombia and Ecuador, including the Mache-Chindul mountain range in northwestern Ecuador, 150–1800 m in elevation.

Phenology.—Flowering apparently occurs year-round; fruiting specimens have been collected from Jan–Feb, and Sep–Dec.

Solanum limoncochaense Tepe, sp. nov. (**Fig. 3**). TYPE. ECUADOR. SUCUMBÍOS: Limoncocha, Reserva Biológica Limoncocha, in wet primary forest near NW corner of lake, 250 m, 22 Jan 2009 (fl, fr), *E.J. Tepe & S. Stern 2627* (HOLOTYPE: QCA!; ISOTYPES, BM!, MO!, NY!, QCNE!, US!, UT!)

Solano dalibardiformi simile sed omnibus organis vegetativus glabris et floribus stellatis differt.

Terrestrial herb, trailing, rooting at the nodes. Stems slender, glabrous. Sympodial units apparently plurifoliate, not geminate. Leaves simple, the blades 3.5–7 × 3.5–8 cm, slightly wider than long, rounded, somewhat fleshy, glabrous; venation palmate with 5 (–7) veins, the base cordate, the margins entire, slightly revolute on some leaves, the apex rounded to obtuse to shortly acuminate; petioles 3–16 cm, glabrous. Internodes

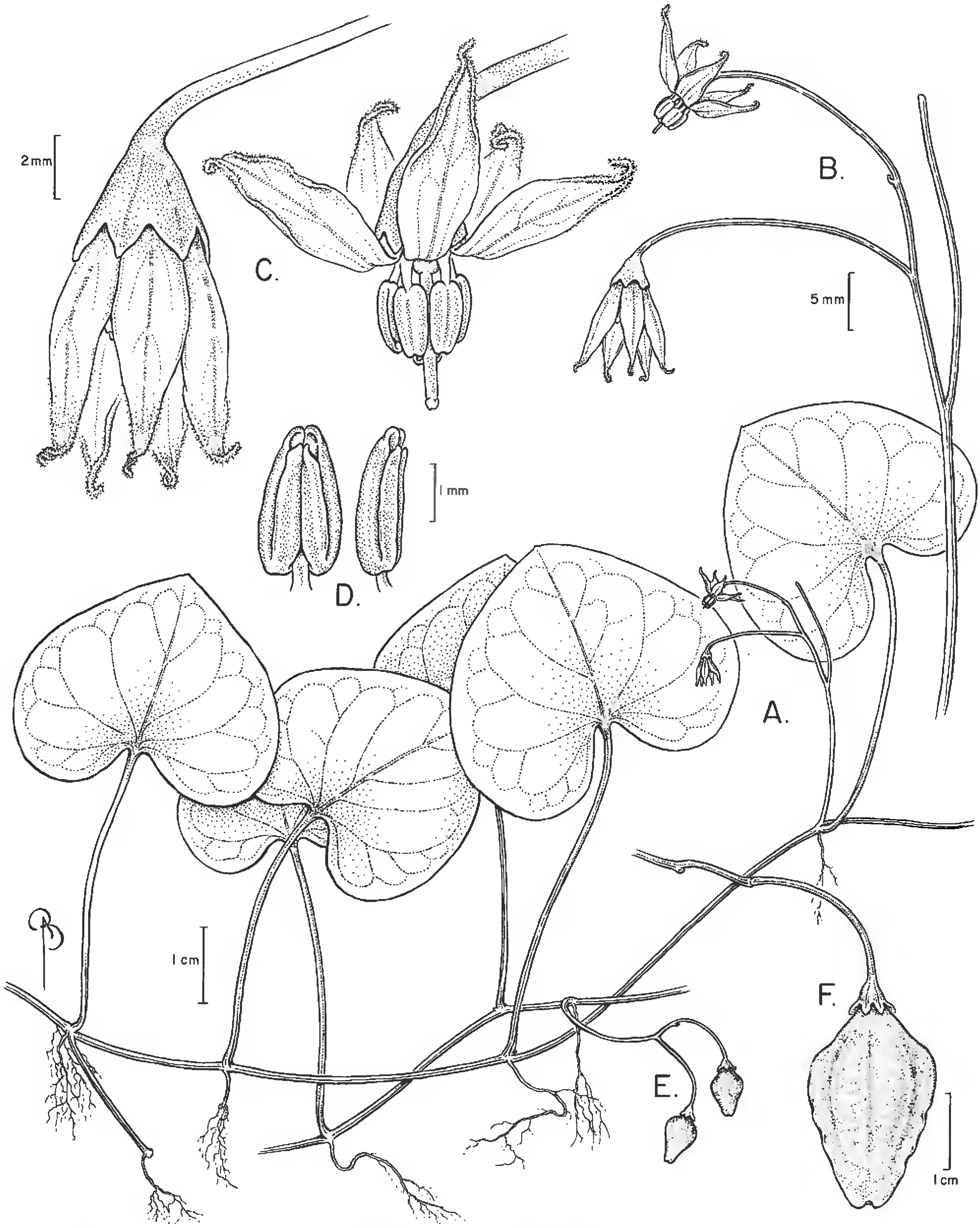


Fig. 3. ***Solanum limoncochaense*** **Tepe. A. Habit. B. Inflorescence. C. Flowers. D. Stamens. E. Infructescence. F. Fruit (immature). (All drawn from** ***M.T. Madison et al. 5327*** **[MO]).**

2.5–20 cm. Inflorescences 4–8 × ca. 3 cm, extra–axillary, unbranched, with 2–3 flowers, all flowers apparently perfect, the axes glabrous; peduncle 1.3–4.5 cm, slender; rachis 0.9–1.5 cm; pedicels 15–25 mm in flower, 25–30 mm in fruit, slender, glabrous, spaced ca. 15 mm apart, articulated at the base. Flowers with the calyx 2.5–4.2 mm long, the tube 1–1.5 mm long, the lobes 1.5–2 × ca. 1.2 mm, rounded, acuminate at tips, glabrous to sparsely pubescent abaxially, densely pubescent adaxially, purplish; fruiting calyx very slightly accrescent, the lobes 1–1.2 × 1.5–2 mm, truncate–acuminate. Corolla 1–1.6 cm in diameter, 5–8 mm long, stellate, membranous, white, the tube 1.5–2 mm, the lobes 6–10 × 1.5–3 mm, lanceolate, narrowly acute at tips, the apex papillose adaxially and abaxially, the margins ciliate apically. Stamens equal, the filaments ca. 1 mm, glabrous; anthers 2–2.5 × ca. 1 mm, slightly tapered, sagittate basally, not connivent, yellow, the pores large and directed distally, opening into longitudinal slits with age. Ovary sparsely papillose; style 2–2.5 × 0.3 mm, straight, cylindrical, stout, sparsely papillose in lower half; stigma capitate, somewhat 2-lobed. Fruits 1–3 × 0.6–3.2 cm, ovoid-rhomboid, flattened, greenish-brown to purplish near apex when immature, bronze-brown when mature, sparsely pubescent with hairs < 0.1 mm to glabrous when mature, the apex truncate to emarginate, strongly fragrant with a sweet, heavy scent, very juicy, the flavor sweet. Seeds 2–2.5 mm in diameter, lenticular, light reddish-brown, the surface minutely rugose.

Additional specimens examined: **ECUADOR. Napo:** Limoncocha on Río Napo, 300 m, 18 Oct 1974 (fl.), *B.A. Drummond 7350* (MO); environs of Limoncocha, 240 m, 16 Jun 1978 (fl, fr), *M.T. Madison et al. 5327* (AAU, F, K, MO, NY, QCA, SEL); near northwest corner of lake, Limoncocha, Sep 1969 (fl), *R.N. Mowbray 699104* (MO).

Solanum limoncochaense belongs to a distinctive group of species within *Solanum* sect. *Herpystichum* characterized by herbaceous, ground-trailing stems that root at the nodes and bizarre, flattened, arrowhead-shaped fruits; this group includes *S. pentaphyllum*, *S. phaseoloides*, *S. dalibardiforme*, and *S. trifolium*. *Solanum limoncochaense* can be distinguished from other species in this group by its simple leaves and stellate flowers. Vegetatively, it is most similar to *S. dalibardiforme* from central Colombia, and most specimens have been annotated as this species. Both species have simple, cordate leaves, but *S. limoncochaense* is distinguishable because all vegetative parts are glabrous, and has stellate rather than rotate corollas. Furthermore, *S. limoncochaense* is found at low elevations, whereas *S. dalibardiforme* is found at elevations > 2000 m. *Solanum limoncochaense* grows in dense, presumably clonal patches on the rainforest floor and over fallen trees. It is apparently a weak climber and living plants in the field were seen climbing trees to no more than 1 m from the ground (E.J. Tepe & S. Stern, pers. obs).

Mature fruits are bronze-brown in color, very juicy, and have a strongly sweet aroma and flavor. The fruits lie on the ground when stems are trailing, or are pendulous on climbing stems. The dispersal agents of these fruits are unknown, but based on the strong scent, color, and presentation, it is likely that they are eaten by rainforest rodents such as the guatusa or agouti (genus *Dasyprocta*; W. Haber, pers. comm.).

Solanum limoncochaense is endemic to Ecuador and all known collections are from the 'terra firme' forests at the northern side of the Limoncocha lake within the Reserva Biológica Limoncocha, a small reserve of 4613 hectares (including the lake which is ca. 250 hectares). Much of the rest of the reserve is made up of swamps and seasonally flooded forests, and *S. limoncochaense* was not encountered in any of the flooded forest habitats. The reserve is surrounded by cultivated land and oil platforms, whose effects on the habitats within it are unknown. If this area is truly the only locality for this species, then it should be considered critically endangered; however, the Reserva de la Biósfera Yasuní is nearby, and much of this enormous reserve has not yet been explored botanically. It is hoped that this species is more widespread than it appears to be based on the collections currently available.

Etymology.—Solanum limoncochaense takes its name from the Laguna de Limoncocha in western Ecuador, the geographic locality of all known collections of the species.

Habitat and Distribution.—This species is apparently endemic to Napo and Sucumbíos Provinces, Ecuador, near the Laguna de Limoncocha, where it grows in primary forests and clearings, 240–300 m in elevation.

Phenology.—Flowering specimens have been collected in Jan, Jun, Sep, and Oct; fruiting specimens have been collected in Jan and Jun.

ACKNOWLEDGMENTS

We thank Stephen Stern and Freddy Villao for assistance in the field; the herbaria AAU, BM, F, K, MO, NY, and SEL for loans of specimens; Ann Kelsey from UT for assistance with loans; David Neill and the staff at QCNE for assistance with logistics in Ecuador; Katy Coral and Hendry Moya of the UISEK Estación Amazónica at Limoncocha; Freddy Villao and the staff at the Centro Científico Río Palenque; and Carlos Aulestia and the Fundación Jatun Satcha for access to the Bilsa Biological Station; Bobbi Angell for the illustrations; and the two anonymous reviewers whose questions and comments improved this manuscript. This work was supported by the NSF through the PBI: *Solanum* grant, DEB-0316614, to LB.

REFERENCES

Bitter, G. 1912. Solana nova vel minus cognita II. Repert. Spec. Nov. Regni Veg. 11:1–18.

Bitter, G. 1913a. Solana nova vel minus cognita VII. Repert. Spec. Nov. Regni Veg. 11:481–491.

Bitter, G. 1913b. Solana nova vel minus cognita X. Repert. Spec. Nov. Regni Veg. 12:49–90.

Correll, D.S. 1962. The potato and its wild relatives. Contr. Texas Res. Found., Bot. Stud. vol. 4. Texas Research Foundation, Renner.

Jørgensen, P.M. and S. León-Yánez (eds.) 1999. Catalogue of the vascular plants of Ecuador.Monogr. Syst. Bot., Missouri Bot. Gard. 75:1–1182.

Knapp, S. 2007. *Solanum coalitum* (Solanaceae), a new endemic species from southern Ecuador. Novon 17: 212–216.

Knapp, S. 2008. A revision of the *Solanum havanense* species group and new taxonomic additions to the Geminata clade (*Solanum*: Solanaceae). Ann. Missouri Bot. Gard. 95:405–458.

Montúfar, R. 2000. Solanaceae. In: R. Valencia, N. Pitman, S. León-Yánes, P.M. Jørgensen, eds. Libro Rojo de las plantas endémicas del Ecuador 2000. Herbario QCA, Pont. Univ. Católica del Ecuador, Quito.

Myers, N., R.A. Mittermeier, C.G. Mittermeier, G.A.B. da Fonseca, and J. Kent. 2000. Biodiversity hotspots for conservation priorities. Nature 403:853–858.

Stern, S.R. and L. Bohs. 2009. Two new species of *Solanum* from Ecuador and new combinations in *Solanum* section *Pachyphylla* (Solanaceae). J. Bot. Res. Inst. Texas 3:503–510.

Weese, T.L. and L. Bohs. 2007. A three-gene phylogeny of the genus *Solanum* (Solanaceae). Syst. Bot. 32: 445–463.

BOOK REVIEW

Margaret B. Gargiullo. 2007. **A Guide to Native Plants of the New York City Region.** (ISBN 0-8135-4042-9, hbk.). Rutgers University Press, 100 Joyce Kilmer Ave # 1, Piscataway, New Jersey 08854, U.S.A. (**Orders:** www.rutgerspress.rutgers.edu, 1-800-848-6224, 1-800-272-6817 fax). $49.95, 306 pp., 131 line drawings, 6 3/8" × 9 1/2"

Presented in this unique guide is a "detailed look at the full scope of flora that is native to this region and available for propagation." The author's definition of native species is plants that were growing in this region before Europeans came to North America. One might think that would place an artificial limit on the plants that would be useable in this day and time. But, as New York City has lost nearly 43% of its native plants, this actually would serve to increase the number of species available for reintroduction or restoration.

Her work is divided into two basic parts. Part 1 is an exploration of the plants of New York City and vicinity, focusing on trees, shrubs, vines, herbs, graminoids, and ferns. Part 2 is a catalog and description of plants for various habitat types. These are followed by a glossary and a bibliography of both print and web resources.

From the publisher: "More than one hundred line drawings of plants and their specific habitats, ranging from forests to beaches, help readers visualize the full potential for landscaping in the area. A separate entry for each plant also provides detailed information on size, flower color, blooming time, and its possible uses in wetland mitigation, erosion control, and natural area restoration. Some plants are also highlighted for their ability to thrive in areas that are typically considered inhospitable to greenery."

"Geared specifically for landscape architects, designers, land managers, and restorationists, this book offers practical advice on how to increase the amount of indigenous flora growing in the metropolitan area, and in some cases, to reintroduce plants that have completely disappeared. Easily searchable by plant type or habitat, this guide is an essential reference for everyone concerned with the region's natural plant life. Since most of the plants can also be grown well beyond the New York City metropolitan area, this book will also be useful for project managers doing restoration work in most of southern New England and the mid-Atlantic region, including Pennsylvania, Delaware, and Maryland."

Recommended for public libraries and research collections, especially those dealing with landscape design and preservation of habitat. This book is not limited geographically to the New England area but is applicable to use elsewhere, as inspiration if nothing else.

Margaret B. Gargiullo has a Ph.D. in plant ecology and has authored several articles on invasive plants and the historical flora of New York City. She worked for New York City's Department of Parks and Recreation, Natural Resources Group, until her retirement in 2006.—*Gary Jennings, Librarian, Botanical Research Institute of Texas, Fort Worth, Texas 76102-4025, U.S.A.*

STENARIA SANCHEZII (RUBIACEAE), A NEW AND ENDANGERED SPECIES FROM SONORA, MEXICO

David H. Lorence

National Tropical Botanical Garden
3530 Papalina Road
Kalaheo, Hawaii 96741, U.S.A.
lorence@ntbg.org

ABSTRACT

A new species of the North American genus *Stenaria* (Raf.) Terrell is described from Sonora, Mexico. **Stenaria sanchezii** is unique in its combination of foliaceous calyx lobes, corollas with a tube c. 9 mm long, and oblong to ellipsoid seeds. Due to its restricted distribution, small population size, and vulnerability to threats from grazing animals and habitat loss, it is considered to be critically endangered (CR) based in IUCN Red List criteria.

Key Words: *Stenaria,* Rubiaceae, Hedyotideae, Spermacoceae, Sonora, Mexico, critically endangered, IUCN Red List

RESUMEN

Se describe una nueva especie del género norteamericano *Stenaria* (Raf). Terrell de Sonora, México. **Stenaria sanchezii** Lorence se caracteriza por tener lóbulos de cáliz foliáceos, corolas con un tubo c. 9 mm de largo, y semillas de oblongas a elipsoides. Debido a su distribución muy restringida con solamente dos individuos conocidos, y debido a la vulnerabilidad al ganado y pérdida de hábitat, se considera como en peligro crítico (CR) basado en los criterios de la Lista Roja de IUCN.

During the course of field work in Sonora, Mexico by Jesús Sánchez-Escalante, Richard Felger, and collaborators two collections were made representing a new species of Rubiaceae belonging to the Spermacoceae s. lat. (Hedyotideae) tribe. Based on morphological characters it is referable to the genus *Stenaria* and is here described as *Stenaria sanchezii* Lorence. The combination of woody herb or subshrub habit, thin non-leathery leaves, foliaceous calyx lobes tapering to a narrow, attenuate base, and corollas with comparatively long tubes to 9 mm long distinguishes *S. sanchezii* from its congeners.

Based on morphological features this new species belongs to the group of Mexican and North American species in the tribe Hedyotideae, currently included by some authors in Spermacoceae s. lat. (Groeninckx et al. 2009). Members of this alliance form a relatively large and taxonomically complex group that is not yet well resolved. Historically, Standley (1918), in his treatment for the North American flora, recognized 48 species which he assigned to either *Houstonia* L. or *Oldenlandia*. Subsequently Lewis (1961, 1962) merged all North American (including Mexican) members of the alliance into *Hedyotis* L. However, *Hedyotis* in the strict sense is an Old World genus ranging from SE Asia to the Caroline Islands of Micronesia with two widespread species in western Polynesia (Church 2003; Terrell et al. 2005). Terrell and Robinson (2003) concluded that the genus is restricted to Asia and the Pacific region with the type species, *Hedyotis fruticosa* L., being from Sri Lanka.

To accommodate North American and Mexican species not referable to *Hedyotis, Houstonia,* or *Oldenlandia,* Terrell and collaborators resurrected or described new genera including *Carterella* Terrell, *Oldenlandiopsis* Terrell & W. Lewis, *Stenaria* (Raf.) Terrell, and *Stenotis* Terrell (Terrell 1987, 1990, 1996, 2001a, 2001b; Terrell & Lewis 1990; Terrell & Robinson 2006).

Although generic delimitations in this complex have not been fully resolved, recent morphological and molecular studies are contributing to a greater understanding of the group. Initial studies of nuclear and chloroplast DNA by Church (2003), suggest that the North American *Houstonia* species are not monophyletic but belong to the same lineage as *Stenaria*. The picture is complex, however, with radiations in this lineage accompanied by descending aneuploidy and apparently other characters such as annual versus perennial habit, heterostylous versus monostylous breeding systems, and evolution of self fertilization, which seem to have originated multiple times (Church 2003). More recent phylogenetic studies of the Hedyotideae s. lat. and Spermacoceae based on chloroplast, plastid, and nuclear DNA regions (Kårehed et al. 2008; Groeninckx,et al. 2009) support *Hedyotis* as being restricted to the Paleotropics and *Houstonia* and *Stenaria* as being American.

Floral, fruit, and seed morphology of this new species indicate it is referable to the group of species which includes *Houstonia nigricans* and related species. These are currently placed in *Stenaria* (Raf.) Terrell, a genus of six species (including this new one) restricted to Mexico and the southwestern United States (Terrell 2001a). The phylogenies of Kårehed et al. (2008: 850) and Groeninckx et al. (2009: 118) based on plastid DNA data place *Stenaria nigricans* (Lam.) Terrell in the *Arcytophyllum-Housonia* clade.

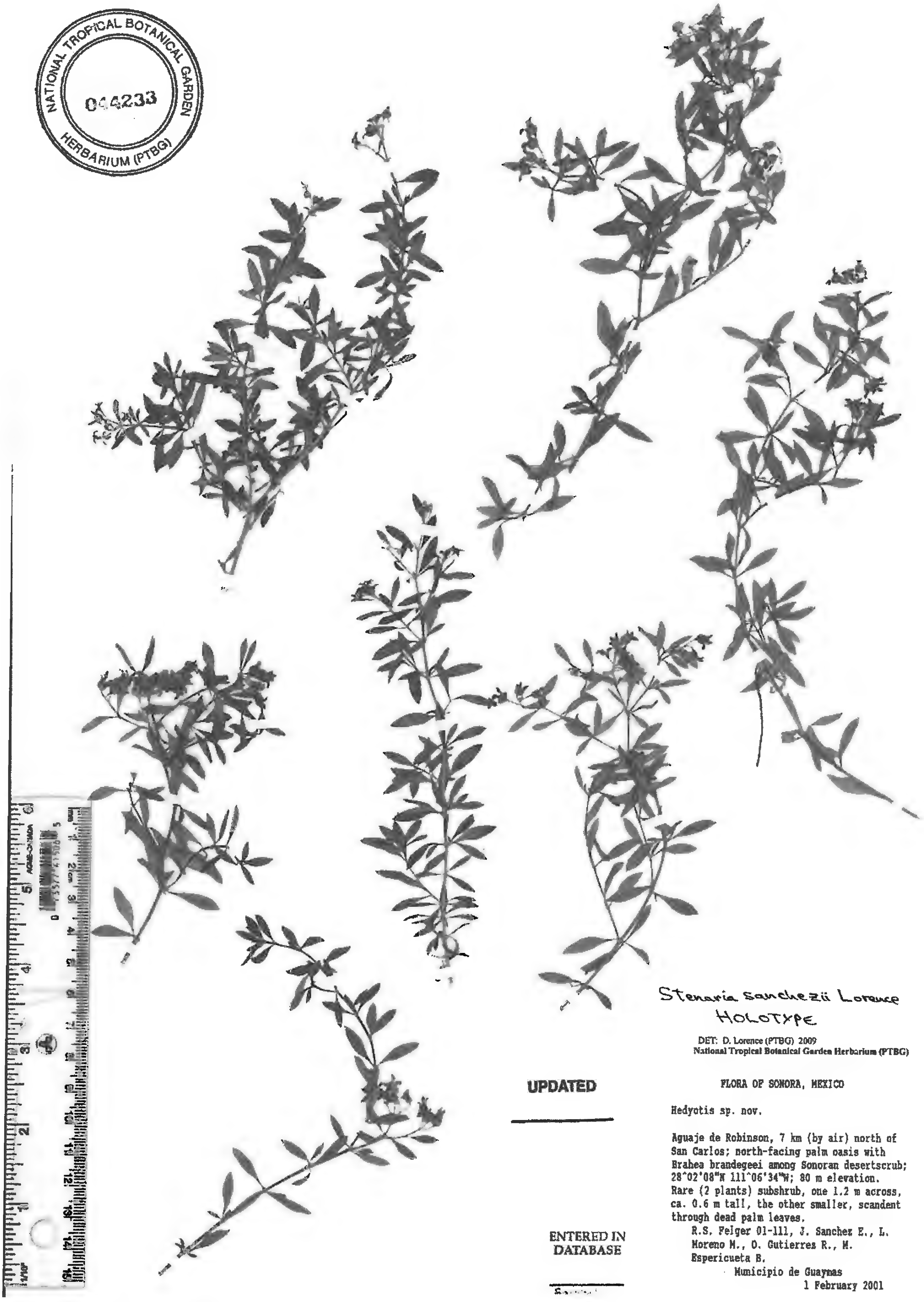
Until the generic delimitations of this complex group are more clearly resolved, it was decided to place the new species in *Stenaria*. Based on its woody perennial habit, thin textured leaf blades, and subglobose capsules, *Stenaria sanchezii* seems closest to *S. nigricans*, which differs in having shorter corollas 2–8.5 mm long with tubes (1.5–)2–4(–5.5) mm long (Terrell 2001a). Corollas are much longer in the new species, although only two mature corollas were available for study. The foliaceous calyx lobes tapering to a narrowly attenuate base in *S. sanchezii* are also very distinctive and in combination with the other characters readily separate it from its congeners.

Stenaria sanchezii Lorence, sp. nov. (**Fig. 1**). TYPE: MEXICO. SONORA: Municipio de Guaymas, Aguaje de Robinson, 7 km (by air) north of San Carlos; 28°2'8"N, 111°6'34"W, 80 m, 1 Feb 2001, *R.S. Felger, J.J. Sánchez-Escalante, L. Moreno-Moreno, O. Gutiérrez-Rochín, & M. Espericueta-Betancourt 01-111* (HOLOTYPE: PTBG 44233; ISOTYPES: ARIZ, USON).

Species *Stenariae nigricante* (Lam.) Terrell affinis, floribus lobis calycinis foliaceis anguste oblanceolatis attenuatis, 3–3.5 mm longis, 0.5–0.8 mm latis, corolla longiore tubo ad 9 mm longo differt.

Woody perennial *herbs* or *subshrubs* 20–60 cm tall, spreading to 120 cm across, basal *stems* woody, 2.5–3 mm in diam., bark pale brown, exfoliating, *leafy twigs* 0.4–0.8 mm diam., densely hirtellous-puberulent with short white trichomes to 0.1 mm long. *Leaves* opposite, sometimes pseudoverticellate with 1–2 smaller leaf pairs in axils, petiolate; petioles 1–3 mm long, 0.15–0.3 mm diam., winged distally, adaxially flattened, minutely puberulent; blades oblanceolate to oblong-elliptic, base cuneate, attenuate and decurrent along petiole, apex abruptly short acuminate to apiculate, thinly chartaceous, both surfaces minutely puberulent when young on costa and margins toward base, glabrescent, venation inconspicuous, secondary veins 3–5 per side, eucamptodromous, higher order venation loosely reticulate; *stipules* interpetiolar, narrowly triangular, sheath 0.2–0.3 mm long, body c. 1 mm long, apex slender, glandular-tipped, margins with 2–4 gland-tipped setae. *Inflorescences* terminal, monochasial, corymbiform, 3–5-flowered, axes puberulent, pedicels 1–4.5 × 0.2 mm, bracteoles subulate or fimbriate, 0.3–0.7 mm long; *flowers* apparently hermaphroditic; *short-styled flowers* with hypanthium broadly ellipsoid-compressed, 0.8–1 mm long and wide, sparsely puberulent, 8-ribbed; calyx tube lacking, calyx lobes 4, equal or subequal, narrowly oblanceolate, 3–3.5 x 0.5–0.8 mm, tapering to narrow base 0.5–0.6 mm wide, apex acuminate, glabrous, venose; *corolla* in bud (possibly not fully expanded) 10 mm long including the lobes, obtuse, at anthesis tube 9 mm long, 0.8 mm wide medially and 1.3 mm wide distally, lobes 4, narrowly ovate-oblong, 2–2.5 x 1–1.1 mm, acute; *stamens* 4, attached just below mouth of tube, subsessile, anthers ellipsoid, 1–1.2 mm long, tips exserted; style included, 6 mm long, puberulent in basal 1/3, stigma 0.8 mm long, slightly bilobed; *long-styled flowers* not seen. *Capsules* 2–3 x 2–2.8 mm, subglobose, dehiscence loculicidal, containing numerous seeds; calyx lobes persistent, 3.5–4 x 1.4–1.5 mm; *seeds* (possibly not fully mature) non-crateriform, moderately compressed, with punctiform hilum, oblong to ellipsoid or broadly ellipsoid, 0.6–0.8 x 0.3–0.5 mm, testa foveolate-reticulate, dark brown.

Etymology.—This new species is named for its first collector, J. Jesús Sánchez-Escalante, Curator of Herbario de la Universidad de Sonora (USON) and founder of the Asociación para las Plantas Nativas de Sonora, A.C. in Hermosillo, in recognition of his efforts to develop USON as a major botanical resource in northwestern México to study and conserve the flora of Sonora, and to inspire young biologists to study plants.


NATIONAL TROPICAL BOTANICAL GARDEN
044233
HERBARIUM (PTBG)
UPDATED
ENTERED IN DATABASE

Stenaria sanchezii Lorence
HOLOTYPE

DET: D. Lorence (PTBG) 2009
National Tropical Botanical Garden Herbarium (PTBG)

FLORA OF SONORA, MEXICO

Hedyotis sp. nov.

Aguaje de Robinson, 7 km (by air) north of San Carlos; north-facing palm oasis with Brahea brandegeei among Sonoran desertscrub; 28^02'08"N 111^06'34"W; 80 m elevation. Rare (2 plants) subshrub, one 1.2 m across, ca. 0.6 m tall, the other smaller, scandent through dead palm leaves.

R.S. Felger 01-111, J. Sanchez E., L. Moreno M., O. Gutierrez R., M. Espericueta B.

Municipio de Guaymas
1 February 2001

Fig. 1. Holotype of *Stenaria sanchezii* Lorence (Felger et al. 01-111, PTBG).

Distribution and habitat.—Known only from the type locality in Sonora. This new species is extremely rare and localized in microhabitats on slopes on the north side of the Sierra El Aguaje. The general vegetation is desertscrub in the Central Gulf Coast subdivision of the Sonoran Desert (Shreve 1964). Felger's (1999) flora of Nacapule in the southeastern Sierra El Aguage provides a good general description of the vegetation and associated species. *Stenaria sanchezii* occurs on rocky substrate in a shady canyon bottom and also in a north-facing palm oasis with *Brahea brandegeei* (Purpus) H. E. Moore and *Ficus petiolaris* (Kunth) subsp. *palmeri* (S. Watson) Felger. Four to five plants were seen in 2000, but only two plants were observed at the same locality in 2001. The area is heavily grazed by cattle, a primary threat to this new species.

Conservation status.—When evaluated using the IUCN criteria for endangerment (IUCN 2001, see also www.iucnredlist.org/info/categories_criteria2001), *Stenaria sanchezii* falls into the Critically Endangered (CR) category, which designates species facing the highest risk of extinction in the wild. IUCN Red List Category: **Critically Endangered** (CR; B1a; B2a, B2b i–iii): B1, extent of occurrence estimated to be less than 100 km^2, and B1a ,known to exist at only a single location. B2, area of occupancy estimated to be less than 10 km^2, and B2a, a single population known. B2b (i–iii), habitat continuing decline inferred. The suitable habitat for *S. sanchezii* at a single locality is indicated as an endangered environment, threatened by human activity (firewood harvesting and fire), grazing, and invasive plants, reducing the extent of the Sonoran desert scrub habitat.

PARATYPE: **MEXICO. SONORA:** Municipio de Guaymas, Aguaje de Robinson, 7 km (by air) N of San Carlos, 28°2'8"N, 111°6'34"W, 80 m, 2 Mar 2000, *J. Sanchez, L. Moreno, M. Espericueta s.n.* (PTBG 44234, USON).

ACKNOWLEDGMENTS

I wish to thank Jesús Sánchez-Escalante for fieldwork leading to the discovery of this new taxon, Tom Van Devender for bringing this new species to my attention, Richard Felger for information on habitat and threats, and the reviewers Edward Terrell and Charlotte Taylor for valuable discussions and comments on the manuscript. Curators of the herbaria ARIZ and USON are thanked for making the specimens available for study.

REFERENCES

CHURCH, S.A. 2003. Molecular phylogenetics of *Houstonia* (Rubiaceae): descending aneuploidy and breeding system evolution in the radiation of the lineage across North America. Molec. Phylogen. Evol. 27:223–238.

FELGER, R.S. 1999. Flora of Cañón Nacapule: a desert-bounded tropical canyon near Guaymas, Sonora. Proc. San Diego Soc. Nat. History 35:1–42.

GROENINCKX, I., S. DESSEIN, H. OCHOTERENA, C. PERSSON, T.J. MOTLEY, J. KÅREHED, B. BREMER, S. HUYSMANS, AND E. SMETS. 2009. Phylogeny of the herbaceous Tribe Spermacoceae (Rubiaceae) based on plastid DNA data. 2009. Ann. Missouri Bot. Gard. 96:109–132.

KÅREHED, J., I. GROENINCKX, S. DESSEIN, T.J. MOTLEY, AND B. BREMER. 2008. The phylogenetic unity of chloroplast and nuclear DNA markers and the phylogeny of the Rubiaceae tribe Spermacoceae. Molec. Phylogen. Evol. 49:843–866.

LEWIS, W.H. 1961. Merger of the North American *Houstonia* and *Oldenlandia* under *Hedyotis*. Rhodora 63: 216–223.

LEWIS, W.H. 1962. Phylogenetic study of *Hedyotis* (Rubiaceae) in North America. Amer. J. Bot. 49:855–865.

SHREVE, F. 1964. Vegetation of the Sonoran Desert. In: F. Shreve and I.L. Wiggins. Vegetation and flora of the Sonoran Desert. Stanford Univ. Press, Stanford, CA. Pp. 9–186.

STANDLEY, P.C. 1918. Rubiaceae (pars). North American Flora 32(1):1–86.

TERRELL, E.E. 1987. *Carterella* (Rubiaceae), a new genus from Baja California, Mexico. Brittonia 39:248–252.

TERRELL, E.E. 1990. Synopsis of *Oldenlandia* (Rubiaceae) in the United States. Phytologia 68:125–133.

TERRELL, E.E. 1996. Revision of *Houstonia* (Rubiaceae-Hedyotideae). Syst. Bot. Monogr. 48:1–118.

TERRELL, E.E. 2001a. Taxonomy of *Stenaria* (Rubiaceae: Hedyotideae), a new genus including *Hedyotis nigricans*. Sida 19:591–614.

Terrell, E.E. 2001b. *Stenotis* (Rubiaceae), a new segregate genus from Baja California, Mexico. Sida 19:899–911.

Terrell, E.E. and W.H. Lewis. 1990. *Oldenlandiopsis* (Rubiaceae), a new genus from the Caribbean Basis, based on *Oldenlandia callitrichoides* Grisebach. Brittonia 42:185–190.

Terrell, E.E. and H. Robinson. 2003. Survey of Asian and Pacific species of *Hedyotis* and *Exallage* (Rubiaceae) with nomenclatural notes on *Hedyotis* types. Taxon 52:775—782.

Terrell, E.E., H.E. Robinson, W.L. Wagner, and D.H. Lorence. 2005. Resurrection of genus *Kadua* for Hawaiian Hedyotidinae (Rubiaceae), with emphasis on seed and capsule characters and notes on South Pacific species. Syst. Bot. 30:818–833.

Terrell, E.E. and H. Robinson. 2006. Taxonomy of North American species of *Oldenlandia* (Rubiaceae). Sida 22:305–329.

BOOK REVIEW

G. Ledyard Stebbins, with V.C. Hollowell, V.B. Smocovitis, and E.P. Duggan (eds). 2007. **The Ladyslipper and I.** (ISBN 978-1-930723-65-8, hbk.). Missouri Botanical Garden Press, PO Box 299, St. Louis, Missouri 63166-0299, U.S.A. (**Orders:** www.mbgpress.org, 1-314-577-9547, orders@mbgpress.org). $35.00, 173 pp., 24 b&w photos, 7 1/4" × 10 1/4".

G. Ledyard Stebbins—one doesn't read far in biology without coming across this name. *The Ladyslipper and I* is his autobiography, synthesized, perhaps much like his theories on evolution, from his own unpublished manuscript. This was a manuscript that he had worked on and rewritten during much of his life. Yet upon his death in 2000, it was still unpublished.

This subtly edited autobiography is a delightful peek into the development and life of an eminent 20th-century evolutionary botanist. Composed of 33 chapters, most about four or five pages long, it's an easy and practical read. Essentially it follows a chronological path but not so strictly as to be predictable or formulaic. The author weaves his social life and interests with his academic pursuits and its personas, all in a pleasant and engaging narrative style. This balance of humorous and sometimes revealing anecdotes of well-known academics and scientists along with their affects on Stebbins' own career are especially entertaining.

The chapters begin with his early life in Seal Harbor, Maine, where he was raised in a typical New England aristocratic home. He tells us of his early appreciation of nature and recounts his school and sibling travails. From there we learn about his boarding school days and finally get to his entrance to Harvard as a freshman. It is in his early years at Harvard that he makes the all-important decision to switch from his initial chosen field of law to one of the sciences.

It's enlightening to hear about these academic days in the early 20th century when Darwinism was not as ensconced as it is today. It's much to the credit of Stebbins and his fellow Neo-Darwinists who took their less-convinced professors to task and explored and advanced the relatively new theory to its present status. Once he earned his PhD and began his career, he became one of the prime players in the development of evolutionary biology. If you were studying botany at a university in the seventies, his story will, no doubt, ring sympathetic neurons as he recounts both social and academic tales about his prominent contemporaries who were coming to the height of their prowess.

But regardless of your background, *The Ladyslipper and I* both entertains and sheds light on the man and his work during some of the most exciting advances in evolutionary biology.—*Robert J George, Botanical Research Institute of Texas, Fort Worth, Texas 76102-4025, U.S.A.*

MUHLENBERGIA TARAHUMARA (POACEAE: CHLORIDOIDEAE: CYNODONTEAE: MUHLENBERGIINAE), A NEW SPECIES FROM CHIHUAHUA, MEXICO

Paul M. Peterson
Department of Botany
National Museum of Natural History
Smithsonian Institution
Washington, DC 20013-7012, U.S.A.
peterson@si.edu

J. Travis Columbus
Rancho Santa Ana Botanic Garden and
Claremont Graduate University
1500 North College Avenue
Claremont, California 91711-3157, U.S.A.
j.travis.columbus@cgu.edu

ABSTRACT

Muhlenbergia tarahumara P.M. Peterson & Columbus, sp. nov., is described and illustrated. The new species occurs on rocky slopes, ridgetops, and white-tuff rock outcrops in the Sierra Madre Occidental and is known only from the municipality of Guachochi in Chihuahua, Mexico. Based on morphological and phylogenetic analysis of plastid and nuclear DNA sequence data, we conclude that the new species is sister to the *Aegopogon* clade that is nested within a clade of species in *Muhlenbergia* subgen. *Muhlenbergia*. *Muhlenbergia tarahumara* differs from *Aegopogon cenchroides* by having panicle branches 5–13 per culm, each with two terminal, one-flowered spikelets; glumes 3–5.8 mm long, shorter than the lemma and narrowly lanceolate; lemmas 3.6–7.3 mm long, lanceolate; paleas 3–4.6 mm long; and anthers 2.2–2.8 mm long, yellowish orange.

RESUMEN

Se describe e ilustra **Muhlenbergia tarahumara** P.M. Peterson & Columbus, sp. nov. La nueva especie habita en cuestas rocosas, en cimas de cerros y en afloramientos de tobas volcánicas blancas en la Sierra Madre Occidental y se conoce solamente en del municipio de Guachochi en Chihuahua, México. Basados en los análisis morfológicos y filogenéticos de las secuencias de ADN plastidial y nuclear, podemos concluir que la nueva especie es hermana del clado *Aegopogon*, el cual se encuentra anidado en el clado de especies de *Muhlenbergia* subgen. *Muhlenbergia*. *Muhlenbergia tarahumara* difiere de *Aegopogon cenchroides* por tener 5–13 ramas por culmo, cada una con dos espiguillas unifloras terminales; glumas de 3–5.8 mm de largo, más largas que el lema y estrechamente lanceoladas; lemas de 3.6–7.3 mm de largo, lanceoladas; páleas de 3–4.6 mm de largo; y anteras de 2.2–2.8 mm de largo, amarillento-anaranjadas.

On a 2003 collecting trip to the Sierra Madre Occidental in Chihuahua, Mexico, two unusual specimens were found and initially given fieldnames of *Aegopogon* (*Peterson & P. Catalán 17542*) and *Bouteloua* (*Peterson & Catalán 17621*). Later, when PMP was preparing treatments of *Bouteloua* and the tribe Muhlenbergiinae for northeastern Mexico (Peterson et al. 2007b; Herrera Arrieta et al. 2008), these specimens were reevaluated after seeing them in the United States National Herbarium (US) in separate unidentified folders of *Aegopogon* and *Bouteloua,* respectively. Upon closer inspection, these collections represented the same new species that could not be easily placed in *Aegopogon* or *Bouteloua,* nor any of the remaining genera currently placed in the Muhlenbergiinae (Peterson et al. 2001b, 2007a). Individuals of this new species are unique in having terminal, raceme-like panicles with only two spikelets at the end of each primary branch. A second opinion seemed warranted; PMP then sent a duplicate off to JTC for examination and incorporation into DNA sequence data sets that could possibly elucidate affinities of this enigmatic species. Subsequently, a third specimen was found (*Peterson et al. 8032*). As discussed below, analyses of DNA sequences from the new species placed it in subtribe Muhlenbergiinae.

Members of subtribe Muhlenbergiinae are grasses (Poaceae) in the subfamily Chloridoideae, tribe Cynodonteae (Peterson et al. 2001b, 2007a, in review). Muhlenbergiinae are highly variable morphologically, although the group can be generally characterized as follows: ligule a membrane (rarely a line of hairs); inflorescence a panicle, rebranched or composed only of primary branches; spikelets solitary, sometimes in pairs or triads, cleistogamous spikelets occasionally present in the leaf sheaths; floret 1 (rarely more), perfect, staminate, or sterile; glumes awned or unawned; lemmas 3-nerved, awned or unawned; base chromosome number $x = 8–10$ (Peterson 2000; Peterson & Herrera Arrieta 1995; Peterson et al. 1997, 2007a, b; Colum-

J. Bot. Res. Inst. Texas 3(2): 527 – 534. 2009

bus et al. 2007). Two subtypes of C_4 photosynthesis, NAD-ME (nicotinamide adenine dinucleotide cofactor malic enzyme) and PCK (phosphoenolpyruvate carboxykinase), have been found and verified by biochemical assays to occur in Muhlenbergiinae (Gutiérrez et al. 1974; Brown 1977; Hattersley & Watson 1992).

By far, the largest genus in the subtribe is *Muhlenbergia*, which has 154 species including the important North American range grass *M. montana* (Nutt.) Hitchc., amphitropical disjuncts *M. arenicola* Buckley and *M. torreyi* (Kunth) Hitchc. ex Bush, and seven species located in southeast Asia (Herrera Arrieta 1998; Peterson & Ortíz Diaz 1998; Peterson 2003; Wu & Peterson 2006; Herrera Arrieta & Peterson 2007; Peterson et al. 2007b). Species indigenous to North America number 127 (86%), and 125 of these occur in Mexico, where 56 species are endemic (Espejo Serna et al. 2000; Dávila-Aranda et al. 2004, 2006; Peterson & Herrera Arrieta 2005; Peterson et al. 2007a).

The remaining nine genera have four or fewer species, and four are monotypic. All are limited to the New World except for an occurrence of *Aegopogon cenchroides* Humb. & Bonpl. ex Willd. in Papua New Guinea (Veldkamp 1985). Five are endemic to North America. Apart from its presence in Papua New Guinea, *Aegopogon* (four species) is distributed in North and South America. *Bealia* (one species) is restricted to northern Mexico (Peterson 1989; Peterson et al. 1993). *Blepharoneuron* (two species) is found in North America and includes *B. tricholepis* (Torr.) Nash, an important range grass in the southwestern U.S.A. and northern Mexico (Peterson & Annable 1990, 2003). *Chaboissaea* (four species) has three species in central Mexico and *C. atacamensis* (Parodi) P.M. Peterson & Annable in Argentina and Bolivia (Peterson & Annable 1992; Peterson & Herrera Arrieta 1995; Sykes et al. 1997). *Lycurus* (three species) has one species limited to North America and two amphitropical disjuncts, including *L. setosus* (Nutt.) C. Reeder (Reeder 1985; Sánchez & Rúgolo de Agrasar 1986; Peterson & Morrone 1998). *Pereilema* (four species) is distributed in North, Central, and South America. *Redfieldia* (one species) is endemic to the U.S.A. (Reeder 1976). *Schaffnerella* (one species) is known only from San Luis Potosí, Mexico (Columbus et al. 2002). *Schedonnardus* (one species) is yet another genus with an amphitropical distribution.

Analyses of cpDNA *ndhA-intron, ndhF, rpl32–trnL*$^{(UAG)}$, *rps3, rps16-intron, rps16–trnK, trnL–F*, and nrDNA ITS sequences of species in the Muhlenbergiinae (Columbus et al. in press; Peterson et al. in prep.) indicate that the large genus *Muhlenbergia*, as delimited above, is not monophyletic because these nine, smaller genera are nested within it; therefore, expanding the circumscription of *Muhlenbergia* to include these nine genera seems warranted (Duvall et al. 1994; Peterson et al. 2001a, 2004; Peterson & Herrera Arrieta 2005; Peterson et al. 2007a). In this paper, in addition to describing a species new to science, we present a phylogenetic hypothesis and support for the generic placement of this unusual taxon.

Muhlenbergia tarahumara P.M. Peterson & Columbus, sp. nov. (**Figs. 1A–J; 2**). Type: MEXICO. Chihuahua. Municipio Guachochi, Sierra Madre Occidental, 2 km W of Rio Coraréachi and E of Osichi (27°28'15.0"N, 107°31'5.0"W), 1960–2040 m, 30 Aug 2003, *P.M. Peterson & P. Catalán 17621* (holotype: US-3470469!; isotypes: CIIDIR!, K!, MO!, RSA!, US!).

Ab *Aegopogon cenchroides* Humb. & Bonpl. ex Willd. paniculis ramis 5–13 per culmo, omnibus cum duobus terminalibus unifloribusque spiculis; glumis 3–5.8 mm longis, brevioribus quam lemmatibus, anguste lanceolatis; lemmata 3.6–7.3 mm longis, lanceolatis; paleae 3–4.6 mm longis; antherae 2.2–2.8 mm longis, tangerinis, recedit.

Caespitose perennials. Culms 18–35 cm tall, erect, terete near base, glabrous below the nodes, usually 3 nodes per culm; internodes glabrous and shiny. Leaf sheaths 0.8–8 cm long, shorter than the internodes above, pubescent above and mostly glabrous below; ligules 1–1.8 mm long, membranous, abaxially pubescent or glabrous, apex acute, often erose, minutely ciliolate; blades (2–)3.5–13 cm long, 0.2–1.3 mm wide, flat to tightly involute, apically acuminate, somewhat sinuous, antrorsely hirsute on both surfaces, the hairs 0.1–0.4 mm long. Panicles 3–6 cm long, 0.7–1.6 cm wide, narrow, terminal with 5–13 racemosely arranged primary branches, 1 per node; branches 0.5–1.4 cm long, with two terminal spikelets, deciduous, disarticulation near base, branches first ascending then spreading (bending sharply or curling near base) from the culm axis, usually secund, antrorsely hirsute, the hairs 0.2–0.4 mm long; inflorescence axis flattened, ending in terminal branch, margins hirsute; pedicels fused or 0.2–0.6 mm long, one slightly longer than the other, tightly appressed. Spikelets 4.5–7.8 mm long, appressed to one another, 1-flowered; glumes 3–5.8 mm long,

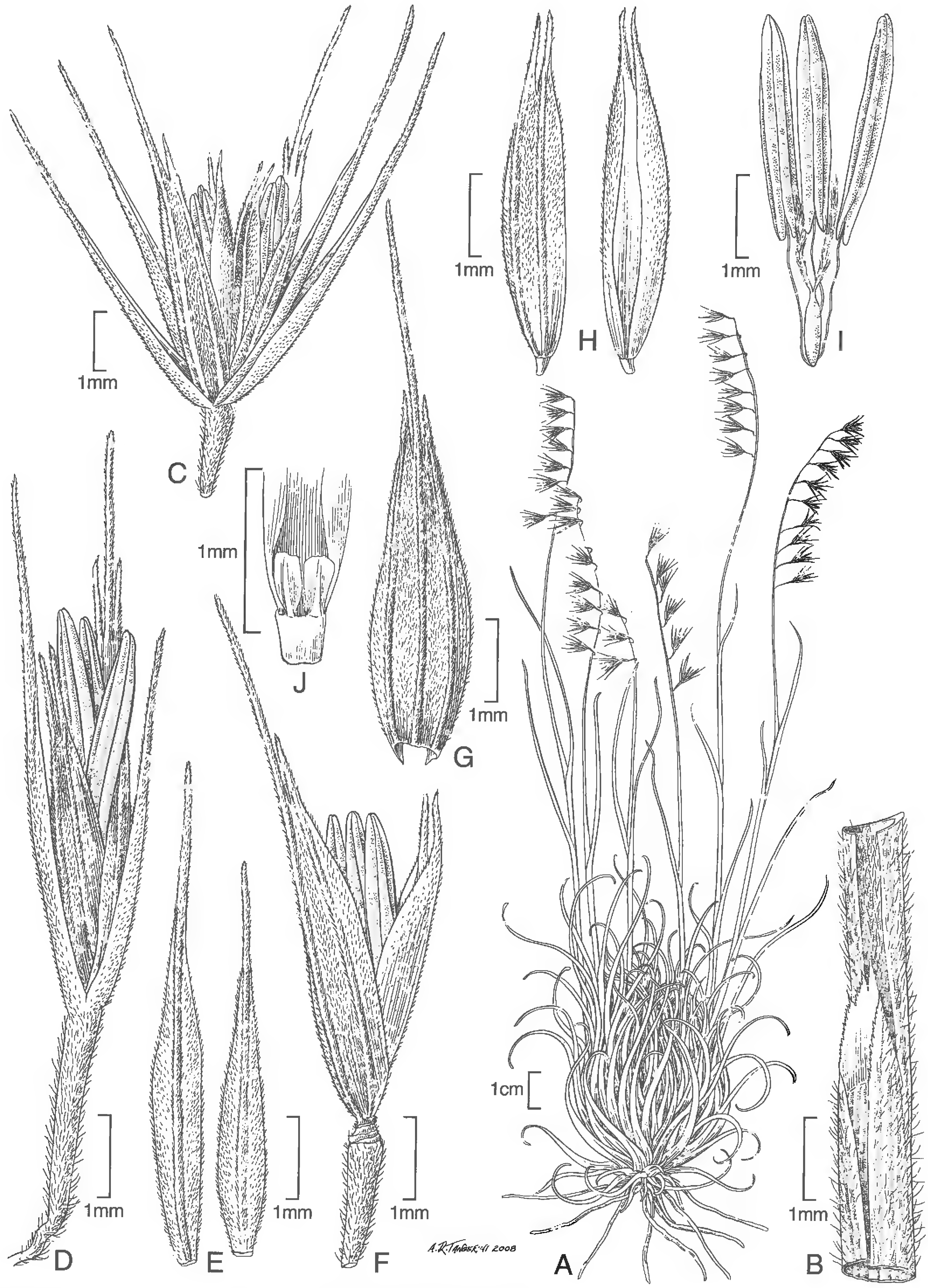

1mm
C
1mm
H
1mm
I
1mm
J
1mm
G
1cm
1mm
D
1mm
E
1mm
F
A.R.Tangerini 2008
A
1mm
B

Fig. 1. *Muhlenbergia tarahumara* [*P.M. Peterson & P. Catalán 17621* (US)]. A. Habit. B. Sheath, ligule, and blade. C. Two paired spikelets. D. Branch with two spikelets (only one seen from this perspective). E. Glumes. F. Floret on branch axis (glumes, other spikelet removed). G. Lemma. H. Paleas. I. Stamens and pistil. J. Lodicules.

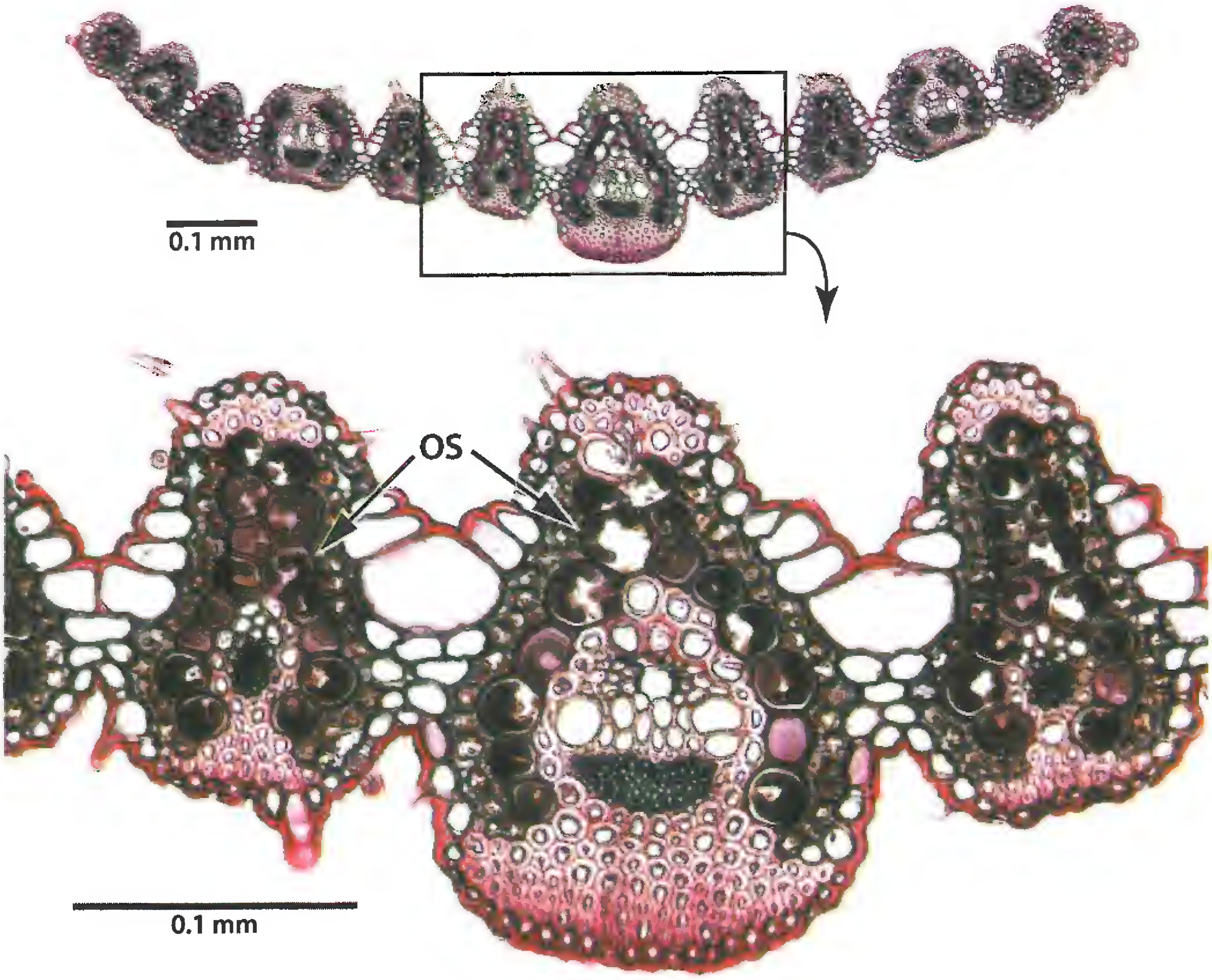


Fig. 2. Transverse section of the leaf blade of *Muhlenbergia tarahumara* [*P.M. Peterson & J.M. Saarela 22053* (US)]. Adaxial surface is at top. OS = outer sheath of vascular bundle.

narrowly lanceolate, usually equal in length, shorter than the lemma, membranous to chartaceous, 1-veined, pubescent, apex acuminate, awned, the awns 1.4–3.2 mm long; lemmas 3.6–7.3 mm long, lanceolate, awned, distinctly 3-veined, membranous to chartaceous, appressed pubescent, apex acute to acuminate, bifid, the central awn 2–3.7 mm long, straight or slightly recurved, the lateral veins extending into awns 0.6–1.3 mm long; paleas 3–4.6 mm long, shorter than the lemma, membranous, glabrous below and appressed pubescent near apex, 2-veined, apex acuminate, each vein extending as a mucro or awn 0.2–0.9 mm long; stamens 3, anthers 2.2–2.8 mm long, yellowish orange; lodicules 2, membranous; ovary glabrous with two styles and two stigmas. Caryopsis not seen.

Comments.—The new species can be distinguished from all other species of *Muhlenbergia* by having a terminal, raceme-like panicle with only two spikelets at the end of the branch. It closely resembles species of *Aegopogon*, which have the same kind of inflorescence, including the deciduous branches, but with three spikelets per branch, and some species of *Bouteloua*. The species is named after the Tarahumara people who are indigenous to the northern Sierra Madre Occidental.

Distribution and Habitat.—*Muhlenbergia tarahumara* is known only from three locations in the Sierra Madre Occidental in Chihuahua, Mexico, where it occurs on rocky slopes, ridgetops, and white-tuff rock outcrops with species of *Pinus, Quercus, Cupressus, Arctostaphylos, Vaccinium, Comarostaphylis, Aristida, Aegopogon tenellus* (DC.) Trin., *A. cenchroides, Muhlenbergia lucida* Swallen, *M. montana, M. pauciflora* Buckley, *M. polycaulis* Scribn., and *M. rigida* (Kunth) Kunth; 1880–2075 m.

Additional specimens examined. **MEXICO. Chihuahua:** Municipio Guachochi, Sierra Madre Occidental, 41.3 km S of Creel on road to Batopilas, 2075 m, 10 Sep 1989, *P.M. Peterson, C.R. Annable & Y. Herrera Arrieta 8032* (RSA, US-3513942); Sierra Madre Occidental, Yamuco, 1 mi E of hwy N of Río Urique crossing towards Basihuare and Creel, 27°23'59.4"N, 107°29'20.4"W, 1880–1900 m, 26 Aug 2003, *P.M. Peterson & P. Catalán 17542* (CIIDIR, RSA, US-3468887); 5 Sep 2008, *P.M. Peterson & J.M. Saarela 22053* (RSA, US); 6 Sep 2008, *P.M. Peterson & J.M. Saarela 22079* (US).

Leaf anatomy.—Cross-sections of the leaf blade were done with a rotary microtome on fresh-field fixed material (*Peterson & Saarela 22053*), stained, and mounted prior to observation (Sharman 1943; Columbus 1999; Peterson & Herrera Arrieta 2001). Permanent slides are deposited at RSA and US. The following description employs much of the standardized terminology proposed by Ellis (1976).

The leaf blade in transverse section displays Kranz anatomy, which is associated with C_4 photosynthesis (Fig. 2). It is nearly flat (becoming involute on drying) and both surfaces have rounded or flat-topped, longitudinal costal (above/below the vascular bundles) ribs alternating with V-shaped intercostal furrows; a conspicuous rounded midrib projects abaxially. The furrows are up to 1/2 the thickness of the blade; those on the abaxial surface are more shallow. The vascular bundles (VBs) have two sheaths, an inner (mestome, XyMS+; Hattersley & Watson 1976) continuous sheath of sclerenchyma and an outer (parenchymatous, PCR tissue; Hattersley et al. 1977) sheath of chlorenchyma. The outer sheath is uneven in outline and its cells contain round chloroplasts that are distributed centrifugally/peripherally within the cell (Prendergast et al. 1987). The VBs differ in size, development of metaxylem, whether or not the outer sheath is continuous, and the amount of sclerenchyma present on the adaxial and abaxial sides. There are four primary VBs (with large metaxylem vessels; includes the midvein), four secondary VBs, and four tertiary VBs arranged as follows: iii-i-iii-i-ii-ii-i-ii-ii-i-iii-iii. The phloem is not sclerosed. In the innermost five VBs, the outer sheath is extended adaxially into the rib. The outer sheath is interrupted by sclerenchyma on the abaxial side of all VBs except three of the four tertiary VBs, and on the adaxial side of the two lateral primary VBs nearest the midvein. A narrow layer of smaller, isodiametric, indistinctly radiate chlorenchymatous cells surrounds the outer sheath (PCA tissue; Hattersley et al. 1977). Sclerenchyma girders (in contact with the outer sheath) are present on the adaxial and abaxial sides of all VBs. The largest girder (many cells in five series/rows) forms the midrib, whereas those of the tertiary VBs are smallest (< 10 cells in one or two series). Abaxial girders associated with primary and secondary VBs, as well as those on the adaxial side of the two lateral primary VBs nearest the midvein, are broadest near the epidermis. The blade margin has two or three subepidermal fibers. Bulliform cells are largest adaxially adjacent to the midvein and become progressively smaller towards the margin; those on the abaxial side are smaller than their adaxial counterparts. Colorless cells one or two columns wide extend between bulliform cells on both sides of the blade, dividing the chlorenchyma associated with adjacent VBs.

Molecular analyses.—DNA was obtained from field-collected leaf material (*Peterson & Saarela 22053*) and was sequenced for *ndhA-intron, ndhF, rpl32–trnL*$^{(UAG)}$, *rps3, rps16-intron, rps16–trnK, trnL–F,* and ITS. To determine the phylogenetic position of the new species within Chloridoideae, the sequences were aligned with the Columbus et al. (2007) data set, representing 66 chloridoid genera and the Peterson et al. (in review) data set representing 96 chloridoid genera. Upon analysis, the new species resolved in the Muhlenbergiinae clade. To determine its position within Muhlenbergiinae, the sequences were aligned with the two separate data sets that included all ten genera in the subtribe and 80–90% of the species in *Muhlenbergia* (Columbus et al. in prep.; Peterson et al. in prep). Analyses of the Muhlenbergiinae data sets revealed that the new species is a member of a subclade that includes *Aegopogon*, *M.* subgen. *Muhlenbergia*, and *Pereilema*. Its position within the subclade was not resolved in the *trnL–F* phylogeny (Columbus et al. in prep.), although in the combined *ndhA-intron, ndhF, rpl32–trnL*$^{(UAG)}$, *rps3, rps16-intron, rps16–trnK* phylogeny (Peterson et al. in prep.) the new species was supported as sister to *Aegopogon cenchroides* and *A. tenellus*. However, in the ITS phylogeny the new species is supported as the sister of *Aegopogon* (Columbus et al. in prep; Peterson et al. in prep.).

DISCUSSION

The new species is unique among members of the Muhlenbergiinae in having only two spikelets per branch, these racemosely arranged along the panicle axis. Reduction of the number of spikelets per branch is also seen in *Muhlenbergia diversiglumis* Trin. (a member of *M.* subgen. *Muhlenbergia*) where there are 2–5 spikelets per branch (Peterson & Annable 1991). However, *M. tarahumara* resembles most closely *Aegopogon* in morphology, which supports the phylogenetic hypothesis that these taxa are sister (Columbus et al. in prep.; Peterson et al. in prep.). *Aegopogon* differs from *M. tarahumara* in having three spikelets per branch. The three spikelets are dimorphic—one is larger and hermaphrodite and two are smaller (sometimes rudimentary; one often not developed in *A. bryophilus* Döll) and staminate or neuter. In *M. tarahumara*, no spikelet dimorphism is evident.

Leaf anatomy suggests *M. tarahumara* undergoes the PCK subtype of C_4 photosynthesis. The presence of two bundle sheaths, uneven outline of the outer sheath, round shape of the chloroplasts in the outer sheath, and the centrifugal/peripheral position of these chloroplasts within each cell are together predictive of PCK (Fig. 2; Prendergast et al. 1987). *Aegopogon* likewise has PCK anatomy (Columbus 1996). Peterson and Herrera Arrieta (2001) reported that the species in *M.* subgen. *Muhlenbergia* possess PCK-like anatomy, whereas the remaining species have NAD-ME anatomy. However, *M. tarahumara* differs from species of *Aegopogon* and *M.* subgen. *Muhlenbergia* by having mesophyll chlorenchyma that forms a narrow layer around the outer sheath and is not continuous between adjacent vascular bundles, being separated by columns of colorless cells. This pattern is partially seen in *M. pauciflora* and *M. polycaulis* (Peterson & Herrera Arrieta 2001), where the vascular bundles near the middle of the blade have columns of colorless cells that separate adjacent vascular bundles. However, near the leaf blade margins the tertiary vascular bundles of *M. pauciflora* and *M. polycaulis* have chlorenchyma cells that are continuous between each adjacent vascular bundle. In addition, *Muhlenbergia pauciflora*, like *M. tarahumara*, has well developed abaxial sclerenchyma girders that are broadest near the epidermis (Peterson & Herrera Arrieta 2001).

ACKNOWLEDGMENTS

We thank the National Geographic Society Committee for Research and Exploration (grant number 8087-06) for field and laboratory support; the Smithsonian Institutions, Restricted Endowments Fund, the Scholarly Studies Program, Research Opportunities, Atherton Seidell Foundation, and Biodiversity Surveys and Inventories Program, all for financial support; Alice R. Tangerini for illustrating the new species; Pedro Acevedo and Ida C. López for correcting the Spanish resumen; Adolfo Espejo Serna and Yolanda Herrera Arrieta for providing helpful comments on the manuscript; and a number of colleagues who assisted with fieldwork.

REFERENCES

Brown, W.V. 1977. The Kranz syndrome and its subtypes in grass systematics. Mem. Torrey Bot. Club 23:1–97.

Columbus, J.T. 1996. Lemma micromorphology, leaf blade anatomy, and phylogenetics of *Bouteloua*, *Hilaria*, and relatives (Gramineae: Chloridoideae: Boutelouinae). Ph.D. dissertation, University of California, Berkeley.

Columbus, J.T. 1999. Morphology and leaf blade anatomy suggest a close relationship between *Bouteloua aristidoides* and *B.* (*Chondrosium*) *eriopoda* (Gramineae: Chloridoideae). Syst. Bot. 23:467–478.

Columbus, J.T., H.L. Bell, R. Cerros-Tlatilpa, M.P. Griffith, and J.M. Porter. 2002. *Schaffnerella* rediscovered! (Gramineae: Chloridoideae). Aliso 20:45–50.

Columbus, J.T., R. Cerros-Tlatilpa, M.S. Kinney, M.E. Siqueiros-Delgado, H.L. Bell, M.P. Griffith, and N.F. Refulio-Rodriguez. 2007. Phylogenetics of Chloridoideae (Gramineae): a preliminary study based on nuclear ribosomal internal transcribed spacer and chloroplast *trn*L–F sequences. Aliso 23:569–579.

Columbus, J.T., P.M. Peterson, N.F. Refulio Rodríguez, R. Cerros Tlatilpa, and M.S. Kinney. In press. Phylogenetics of Muhlenbergiinae (Poaceae, Chloridoideae, Cynodonteae) based on ITS and *trnL–F* DNA sequences. Fifth International Symposium on Grass Systematics and Evolution, Copenhagen.

Dávila-Aranda, P.R. Lira-Saade, and J. Valdés-Reyna. 2004. Endemic species of grasses in Mexico: a phytogeographic approach. Biodivers. & Conservation 13:1101–1121.

Dávila, P., M.T. Mejía-Saulés, M. Gómez-Sánchez, J. Valdés-Reyna, J.J. Ortíz, C. Morín, J. Castrejón, and A. Ocampo. 2006. Catálogo de las gramíneas de Mexico. Universidad Nacional Autónoma de Mexico and Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, Mexico, D.F.

Duvall, M.R., P.M. Peterson, and A.H. Christensen. 1994. Alliances of *Muhlenbergia* (Poaceae) within New World Eragrostideae are identified by phylogenetic analysis of mapped restriction sites from plastid DNA's. Amer. J. Bot. 81:622–629.

Ellis, R.P. 1976. A procedure for standardizing comparative leaf anatomy in the Poaceae. I. The leaf-blade as viewed in transverse section. Bothalia 12:65–109.

Espejo Serna, A., A.R. López-Ferrari, and J. Valdés-Reyna. 2000. Poaceae. In: A. Espejo Serna and A.R. López-Ferrari. Las monocotiledóneas Mexicanas: una sinopsis florística, Partes IX–XI, Pandanaceae a Zosteraceae. Consejo Nacional de la Flora de Mexico, A.C., Universidad Autónoma Metropolitana-Iztapalapa, and Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, Mexico, D.F. Pp. 8–236.

Gutiérrez, M., V.E. Gracen, and G.E. Edwards. 1974. Biochemical and cytological relationships in C_4 plants. Planta 119:279–300.

Hattersley, P.W. and L. Watson. 1976. C_4 grasses: an anatomical criterion for distinguishing between NADP-malic enzyme species and PCK or NAD-malic enzyme species. Austral. J. Bot. 24:297–308.

Hattersley, P.W. and L. Watson. 1992. Diversification of photosynthesis. In: C.P. Chapman, ed. Grass evolution and domestication. Cambridge University Press, Cambridge. Pp. 38–116.

Hattersley, P.W., L. Watson, and C.B. Osmond. 1977. *In situ* immunofluorescent labelling of ribulose-1, 5-bisphosphate carboxylase in leaves of C_3 and C_4 plants. Austral. J. Pl. Physiol. 4:523–539.

Herrera Arrieta, Y. 1998. A revision of the *Muhlenbergia montana* (Nutt.) Hitchc. complex (Poaceae: Chloridoideae). Brittonia 50:23–50.

Herrera Arrieta, Y. and P.M. Peterson. 2007. *Muhlenbergia* (Poaceae) de Chihuahua, Mexico. Sida Bot. Misc. 29: 1–109.

Herrera Arrieta, Y., P.M. Peterson, and J. Valdés-Reyna. 2008. *Bouteloua* (Poaceae: Chloridoideae: Cynodonteae: Boutelouinae) del noreste de Mexico. *J. Bot. Res. Inst. Texas* 2:917–981.

Peterson, P.M. 1989. A re-evaluation of *Bealia mexicana* (Poaceae: Eragrostideae). Madroño 36:260–265.

Peterson, P.M. 2000. Systematics of the Muhlenbergiinae (Chloridoideae: Eragrostideae). In: S.W.L. Jacobs and J. Everett, eds. Grasses: systematics and evolution. CSIRO, Collingwood, Victoria, Australia. Pp. 195–212.

Peterson, P.M. 2003. *Muhlenbergia*. In: M.E. Barkworth, K.M. Capels, S. Long, and M.B. Piep, eds. Flora of North America north of Mexico. Oxford University Press, New York and Oxford. 25:145–201.

Peterson, P.M. and C.R. Annable. 1990. A revision of Blepharoneuron (Poaceae: Eragrostideae). Syst. Bot. 15: 515–525.

Peterson, P.M. and C.R. Annable. 1991. Systematics of the annual species of Muhlenbergia (Poaceae-Eragrostideae). Syst. Bot. Monogr. 31:1–109.

Peterson, P.M. and C.R. Annable. 1992. A revision of Chaboissaea (Poaceae: Eragrostideae). Madroño 39:8–30.

Peterson, P.M and C.R. Annable. 2003. Blepharoneuron. In: M.E. Barkworth, K.M. Capels, S. Long, and M.B. Piep, eds. Flora of North America north of Mexico. Oxford University Press, New York and Oxford. 25:47, 48, 50.

Peterson, P.M, J.T. Columbus, R. Cerros-Tlatilpa, and M.S. Kinney. 2001a. Phylogenetics of Muhlenbergia and relatives (Poaceae: Chloridoideae) based on internal transcribed spacer region sequences (nrDNA). Botany 2001 abstract: http://www.botany2001.org/section12/abstracts/33.shtml

Peterson, P.M., J.T. Columbus, and S.J. Pennington. 2007a. Classification and biogeography of New World grasses: Chloridoideae. Aliso 23:580–594.

Peterson, P.M. J.T. Columbus, N.F. Refulio-Rodríguez, R. Cerros-Tlatilpa, and M.S. Kinney. 2004. A phylogeny of the Muhlenbergiinae (Poaceae: Chloridoideae: Cynodonteae) based on ITS and *trnL–F* sequences. Botany 2004 abstract: http://www.2004.botanyconference.org/engine/search/index.php?func=detail&aid=38

Peterson, P.M., M.R. Duvall, and A.H. Christensen. 1993. Allozyme differentiation among *Bealia mexicana, Muhlenbergia argentea*, and *M. lucida* (Poaceae: Eragrostideae). Madroño 40:148–160.

Peterson, P.M. and Y. Herrera Arrieta. 1995. Allozyme variation in the amphitropical disjunct *Chaboissaea* (Poaceae: Eragrostideae). Madroño 42:427–449.

Peterson, P.M. and Y. Herrera Arrieta. 2001. A leaf blade anatomical survey of *Muhlenbergia* (Poaceae: Muhlenbergiinae). Sida 19:469–506.

Peterson, P.M. and Y. Herrera Arrieta. 2005. Evolución de las Muhlenbergiinae (Poaceae: Chloridoideae) en Mexico. Simposio Internacional "El Conocimiento Botánico en la Gestión Ambiental y el Manejo de Ecosistemas" y 2° Simposio Botánico del Norte de Mexico: Resumenes:23–24.

Peterson, P.M. and O. Morrone. 1997 (1998). Allelic variation in the amphitropical disjunct *Lycurus setosus* (Poaceae: Muhlenbergiinae). Madroño 44:334–346.

Peterson, P.M. and J.J. Ortíz-Diaz. 1998. Allelic variation in the amphitropical disjunct *Muhlenbergia torreyi* (Poaceae: Muhlenbergiinae). Brittonia 50:381–391.

Peterson, P.M., K. Romaschenko, and G. Johnson. In review. A classification of the Chloridoideae (Poaceae) based on multi-gene phylogenetic trees. Mol. Phylogenet. Evol.

Peterson, P.M., R.J. Soreng, G. Davidse, T.S. Filgueiras, F.O. Zuloaga, and E.J. Judziewicz. 2001b. Catalogue of New World grasses (Poaceae): II. Subfamily Chloridoideae. Contr. U.S. Natl. Herb. 41:1–255.

Peterson, P. M., J. Valdés-Reyna, and Y. Herrera Arrieta. 2007b. Muhlenbergiinae (Poaceae: Chloridoideae: Cynodonteae) from northeastern Mexico. J. Bot. Res. Inst. Texas 1:933–1000.

Peterson, P.M., R.D. Webster, and J. Valdés-Reyna. 1995. Subtribal classification of the New World Eragrostideae (Poaceae: Chloridoideae). Sida 16:529–544.

Peterson, P.M., R.D. Webster, and J. Valdés-Reyna. 1997. Genera of New World Eragrostideae (Poaceae: Chloridoideae). Smithsonian Contr. Bot. 87:1–50.

Prendergast, H.D.V., P.W. Hattersley, and N.E. Stone. 1987. New structural/biochemical associations in leaf blades of C_4 grasses (Poaceae). Austral. J. Pl. Physiol. 14:403–420.

Reeder, C.G. 1985. The genus *Lycurus* (Gramineae) in North America. Phytologia 57:283–291.

Reeder, J.R. 1976. Systematic position of *Redfieldia* (Gramineae). Madroño 23:434–438.

Sánchez, E. and Z.E. Rúgolo de Agrasar. 1986. Estudio taxonómico sobre el género *Lycurus* (Gramineae). Parodiana 4:267–310.

Sharman, B.C. 1943. Tannic acid and iron alum with safranin and orange G in studies of the shoot apex. Stain Technol. 18:105–111.

Sykes, G.R., A.H. Christensen, and P.M. Peterson. 1997. A chloroplast DNA analysis of *Chaboissaea* (Poaceae: Eragrostideae). Syst. Bot. 22:291–302. \

Veldkamp, J.F. 1985. *Aegopogon* (Gramineae) in Malesia. Reinwardtia 10:115–117.

Wu, Z. and P.M. Peterson. 2006. *Muhlenbergia.* In: Wu, Z., P.H. Raven, and H. Deyuan, eds. Flora of China: Poaceae. Science Press and Missouri Botanical Garden Press, Beijing and St. Louis. 22:486–487.

UNA NUEVA ESPECIE Y NOVEDADES NOMENCLATURALES EN EL GÉNERO *MELIOSMA* (SABIACEAE)

J. Francisco Morales

Instituto Nacional de Biodiversidad (INBio), Apto 22--3100
Santo Domingo de Heredia, COSTA RICA
fmorales@inbio.ac.cr

RESUMEN

Se describe **Meliosma isthmensis,** una nueva especie de Costa Rica y Panamá y se discuten sus afinidades taxonómicas. *Meliosma hartshornii* A.H. Gentry es reducida a la sinonimia de **M. irazuensis** Standl.

ABSTRACT

Meliosma isthmensis, a new species from Costa Rica, and Panama, is described and its taxonomic relationships are discussed. *Meliosma hartshornii* A.H. Gentry is reduced to the synonymy of **M. irazuensis** Standl.

PALABRAS CLAVE: Sabiaceae, *Meliosma*, Costa Rica, Panamá

Meliosma (Sabiaceae) es un género de distribución amfipacífica con una interesante disjunción entre el SE de Asia hasta Malasia y la America tropical, presentando una mayor diversidad en Centro América y los Andes tropicales (Kubitzki 2004, 2006). En el tratamiento de la Flora de Panamá, Gentry (1980) registró un aproximado de 40 especies en América (vs. 15 en el Asia). Desde entonces, se han realizado numerosas publicaciones de novedades taxonómicas (e.g., Arbeláez 2004; Aymard & Cuello 1994; Cornejo & Bonifaz 2006; Cuatrecasas 1988; Cuatrecasas & Idrobo,1988; Gentry 1986, 1992; Menjivar et al. 2008; Morales 2003; Steyermark & Gentry 1992) y compilaciones en floras y catálogos (e.g., Flora de Venezuela (Steyermark & Gentry 1992); Flora de Nicaragua (Gentry 2001); Flora de la Guyana Venezolana (Aymard & Cuello 2005), por lo que actualmente el número total de especies del género se ubica entre 80 y 90, con cerca de 70 restringidas al Nuevo Mundo. Sin embargo, ante la carencia de trabajos monográficos recientes, que traten en forma total o parcial las especies de *Meliosma* en el neotrópico, es probable que el número real pueda ser menor, sobretodo ante la presencia de posibles sinónimos nomenclaturales en taxones de Sur América.

La separación infragénerica más utilizada ha sido la propuesta por Van Beusekon (1971), en la cual subdivide el género *Meliosma* en dos subgéneros: *Meliosma* y *Kingsboroughia* (Liebermann) Beusekom. El primero incluye la secciones *Meliosma* y *Lorenzanea* (Liebermann) Beusekom, mientras que *Kingsboroughia* esta dividido en las secciones *Kingsboroughia* y *Hendersonia* Beusekom. El subgénero *Meliosma* se diferencia de *Kingsboroughia* por poseer las hojas por lo general simples (vs. pinnadas), cinco sépalos (vs. cuatro), pétalos externos de igual tamaño, estrechamente imbricados, subredondeados hasta anchamente elípticos (vs. más anchos que largos, anchamente imbricados, reniformes) y presencia de un haz vascular (el cual conecta el pedicelo de la semilla) situado en un canal marginal dentro del endocarpo, (vs. situado fuera del endocarpo o libre en la pulpa del mismo). Todas las especies neotropicales se encuentran incluidas en la sección *Lorenzanea*, excepto *M. alba* (Schltdl.) Walp., (disjuncta del SE de México y SE de Asia) la cual pertene a la sección *Kingsboroughia*.

Durante el proceso de elaboración de una revisión del género en México y Centroamérica, se han encontrado una serie de novedades taxonómicas, entre las que se incluyen varias especies sin describir, así como la necesidad de reducir a la sinonimia algunos taxones. A continuación se describe una especie nueva para Costa Rica y Panamá, discutiéndose las relaciones con las especies más relacionadas y se propone un nuevo sinónimo nomenclatural.

J. Bot. Res. Inst. Texas 3(2): 535 – 540. 2009

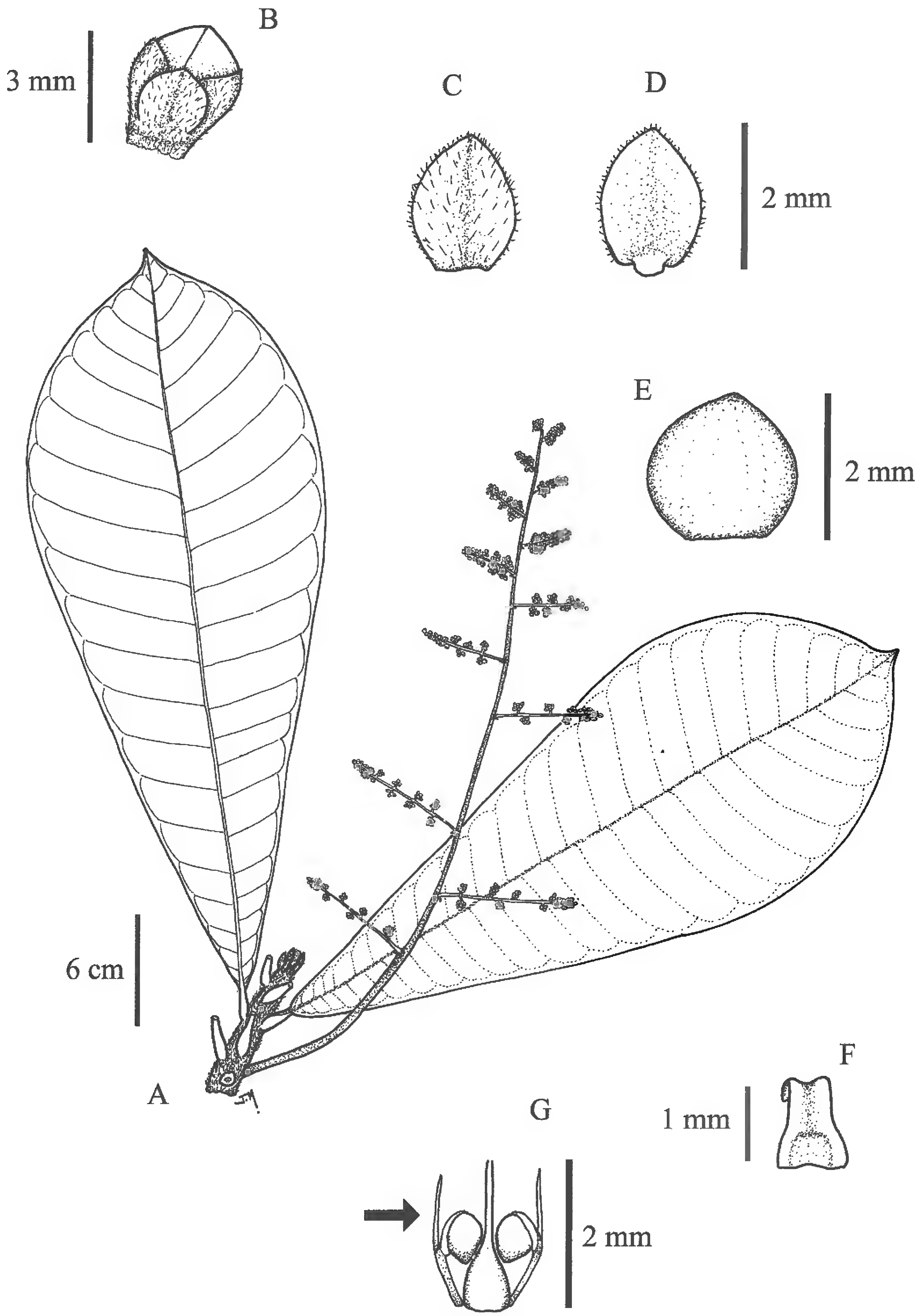


Fig. 1. *Meliosma isthmensis* (A–G de *Aguilar, Woodward & Keefe 4177*, INB; H de *Chacon 135*, CR). **A.** Rama con inflorescencia. **B.** Detalle de un botón floral. **C.** Sépalo, vista abaxial. **D.** Sépalo, vista adaxial. **E.** Pétalo externo, vista abaxial. **F.** Estaminodio. **G.** Estambres, ovario y pétalo interno (señalado por una flecha).

Meliosma isthmensis J.F. Morales, sp. nov. (**Fig. 1**). Tipo. COSTA RICA Limón: cantón de Pococí, llanura de Santa Clara, finca La Suerte, 50 m, 8 jul 1995 (fl), *R. Aguilar, C. Woodward & K. Keefe 4177* (holotipo: INB; isotipos: CR, MO).

A *Meliosma schilimii* (Turcz.) Triana, cui affinis, ramulis hirsutulis et foliis basi cuneatis differt.

Árboles de 7–14 m de altura, tallos cilíndricos a subcilíndricos, con lenticelas esparcidas, y más o menos circulares, las yemas y tallos jóvenes densamente ferrugíneo–pubescentes, el indumento hirsutulo, los tallos viejos con el indumento más esparcido y algo adpreso. Hojas alternas, a veces más o menos aglomeradas al final de las ramitas, cortamente pecioladas, el pecíolo 1,1–1,9 cm de largo, esparcidamente hirsutulo hasta glabrescente, pulvínulo presente, pero apenas evidente; lámina 35–55 × 8–17,5 cm, obovada a angostamente obovada, el ápice agudo, la base angostamente cuneada, a veces prolongándose tenuamente en el peciolo, no revoluta, el margen entero y no revoluto, no bulladas, glabrescentes en el haz, la pubescencia restringida sobre la costa de las nervaduras, densa a moderamente puberulentas o tomentulosas en el envés, la pubescencia màs o menos distribuida por toda la lámina, con 37 a 46 (o más) pares de venas secundarias, las venas terciarias conspicuamente reticuladas en la superificie abaxial, las venas apenas visibles en la superficie adaxial. Inflorescencias panículas, laterales o axilares (aparentemente subterminales en las ramas jóvenes), tripinadas, 13–40 cm de largo, esparcidamente puberulentas, el indumento incoloro, brácteas 1-3 mm de largo, filiformes, bracteólas 0,4–0,6 mm de largo, angostamente ovadas, escariosas; flores densamente aglomeradas, sésiles a subsésiles, con pedicelos (cuando presentes hasta 0,7 mm de longitud), sépalos 5, de 1,3–1,9 mm de largo, anchamente ovados, el ápice agudo u obtuso, esparcidamente hirsutulos externamente, el margen ciliado; pétalos crema a verde–crema, 5, desiguales en tamaño, los 3 externos 1,9–2,2 mm de largo, anchamente ovados a suborbiculares, glabros, exceptos por unos cuantos cilios esparcidos en el margen, los 2 internos 0,9-1,2 mm de largo, ubicados dorsalmente sobre los filamentos y sobrepasándolos, lineares, glabros; estambres 5, pero solo 2 fértiles, las tecas 06-0,9 mm de largo, los estaminodios 1,1–1,4 mm de largo, angostamente subovados, glabros; ovario 0,3–0,6 mm de largo, glabro. Frutos 2,2–2,6 × 1,9–2,2 cm, obovoide-piriformes, blanco verdosos al madurar.

Distribución, habitat y ecología.—Restringida a la vertiente caribe de Costa Rica y Panamá, donde crece en bosques muy húmedos en elevaciones de 100–1000 m. Especímenes con flores han sido recolectados en febrero, junio y julio. Frutos se han observado en marzo, mayo, junio y de agosto a octubre.

Meliosma isthmensis habiá sido identificado como *M. schlimii* (Turcz.) Triana en la sinopsis del género *Meliosma* para Costa Rica y Panamá (Morales 2003). Sin embargo, a través del estudio de numerosos duplicados (adicional a la colección tipo) depositados en diferentes herbarios colombianos y ecuatorianos, se concluye, que *M. schilimii* es un taxón restringido a las zonas altas de los Andes en Colombia y Ecuador y la especie presente en Costa Rica y Panamá representa un taxón diferente, restringido a bosques muy húmedos, de elevaciones bajas y medias bajo los 1000 m de elevación. *Meliosma isthmensis* difiere de *M. schlimii* por sus tallos jóvenes y yemas con el indumento hirsutulo y de color ferrugíneo (vs. puberulento e incoloro), láminas foliares con la base no revoluta (vs. revoluta), no bulladas, así como flores densamente aglomeradas (vs. no aglomeradas), y habitáts diferentes, ya que *M. isthmensis* se encuentra confinada a bosques muy húmedos en zonas bajas (100–1000 m) de la vertiente atlántica en Costa Rica y Panamá, mientras que *M. schlimii* está restringida a bosques montanos, sobre los 2200 m en Colombia y Ecuador.

Especímenes adicionales examinados. **COSTA RICA. Cartago:** Chitaria, Turrialba, 22 jun 1972 (fl, fr), *Poveda 183* (MO). **Limón:** Reserva indígena Talamanca, quebrada Heliotropo, entre Sukut y Purisqui, 9 jul 1989 (fr), *Chacon 135* (CR, MO); al SO de Bribri, 4 may 1983 (fr), *Gomez et al. 20469* (MO); Almirante, entre ríos Xichiary y Boyei, 11 ago 1995 (fr), *Herrera 8390* (CR); El Cedral, al N de Cariari, 16 sep 1994 (fr), *Thomsen 1213* (CR); Talamanca, fila Carbón, Buena Vista, 28 mar 1997 (fr), *Valverde 27* (CR). **PANAMA. Coclé:** río San Juan, 12 jun 1978 (fr), *Hammel 3450* (MO). **Colón:** fila Santa Rita, al SE de Colon, 21 may 1986 (fr), *McPherson 9207* (MO); Santa Rita, 29 may 1975 (fr), *Mori & Crosby 6411* (MO). **PANAMÁ:** cerro Jefe, cerca del río Indio, 17 feb 1968 (fl), *Duke 15213* (MO). **San Blas:** entre Yannuadi y la costa, Nargana, 25 oct 1992 (fr), *Herrera 1260* (MO).

Meliosma irazuensis Standl., Arch. Bot. Sist. 9(3–4):194. 1933. (**Fig. 2**). Tipo: COSTA RICA. Cartago: Volcán Irazú, cerca de Guayabillos, 2500 m, 22 may 1930 (fl), *G. Cufodontis 451* (holotipo: F [fotocopia, MO]; isotipos: EAP [fragmento], W).

Meliosma hartshornii A.H. Gentry, Ann. Missouri Bot. Gard. 73:820. 1986 [1987], **syn. nov.** Tipo: COSTA RICA. Heredia: camino al Volcán Barba, 2 km al N de Sacramento, 2750 m, 29 dic 1974 (fl), *G. Hartshorn 1608* (holotipo: MO; isotipo: CR)

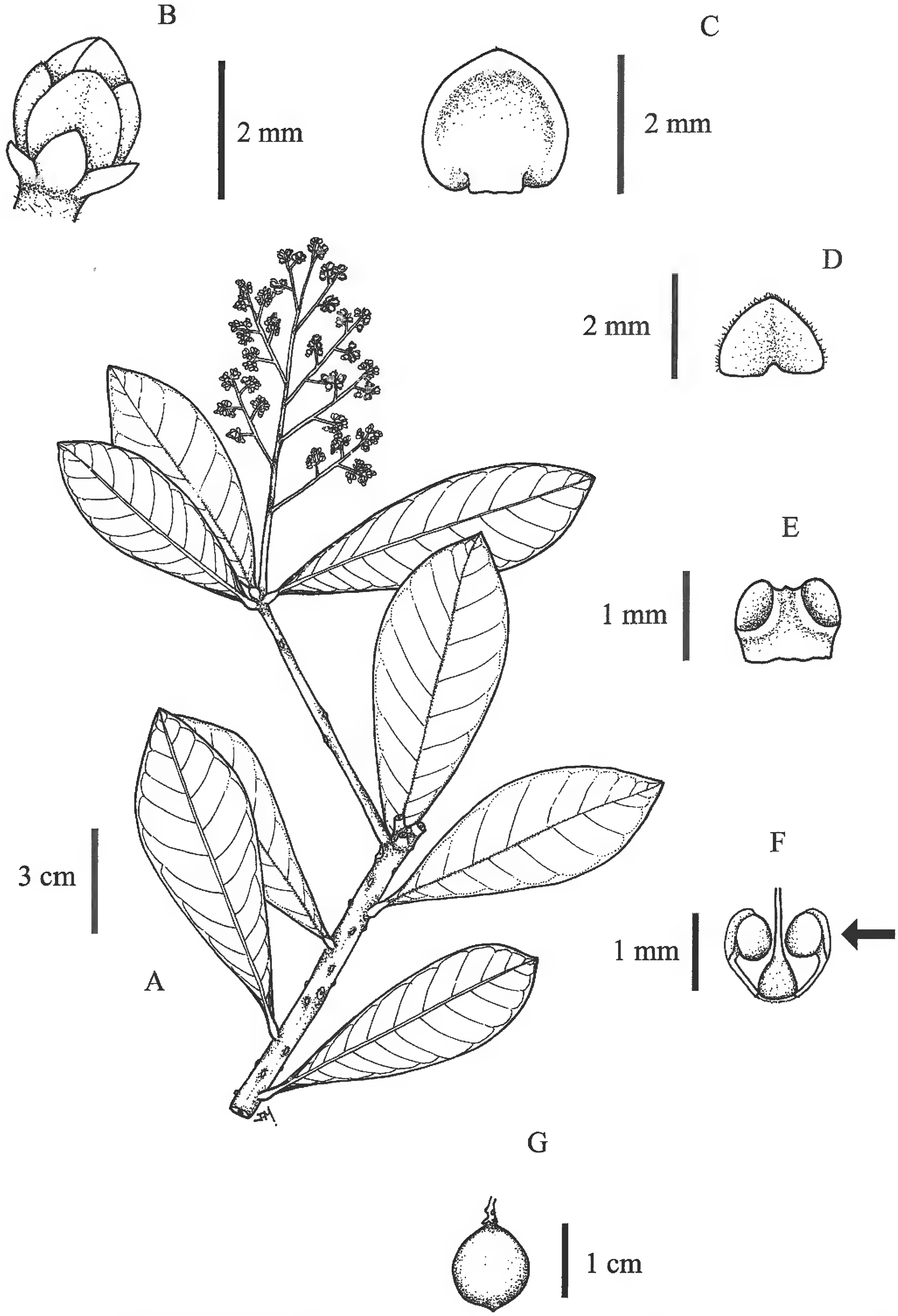


Fig. 2. *Meliosma irazuensis* (A–F de *Herrera 3631*, INB; G de *Morales 8664*, INB). **A.** Rama con inflorescencia. **B.** Detalle de un botón floral. **C.** Sépalo, vista adaxial. **D.** Pétalo externo, vista adaxial. **E.** Estaminodio. **F.** Estambres, ovario y pétalo interno (señalado por una flecha). **G.** Fruto.

Árboles de 8–18 m de altura, tallos cilíndricos a subcilíndricos, con lenticelas esparcidas, y más o menos circulares, elevadas, las yemas y tallos jóvenes densamente hirsutulos a adpreso-pubescentes, el indumento amarillo, los tallos viejos glabrescentes. Hojas alternas, a veces más o menos aglomeradas al final de las ramitas y pareciendo verticiladas o subverticiladas, cortamente pecioladas, el pecíolo 0,5–1,2 cm de largo, esparcidamente puberulento hasta glabro o glabrescente, el pulvínulo presente, evidente; lámina 3,5–11,5(–16,5) × (1,4–)2,4–4,6(–5,5) cm, elíptica, obovado-elíptica a obovada, el ápice agudo, la base angostamente cuneada, prolongándose en el peciolo, usualmente revoluta, el margen entero a espaciadamente dentado, no bulladas, glabras en el haz, esparcida e inconspicuamente pubescentes abaxialmente, con 8 a 14 pares de venas secundarias, las venas terciarias finamente reticuladas en la superificie abaxial, las venas apenas visibles en la superficie adaxial. Inflorescencias panículas, terminales o subterminales en ramas jóvenes, volviéndose axilares con la edad, tripinadas, (4–)7–15 cm de largo, densa a moderadamente puberulentas, el indumento algo ferrugíneo, brácteas 1,2–2,1 mm de largo, angostamente ovadas, bracteólas 0,8–1,4 mm de largo, ovadas, escariosas, dispuestas inmediatamente debajo del cáliz y semejando sépalos; flores densamente aglomeradas, sésiles a subsésiles, con pedicelos (cuando presentes) hasta 1,3 mm de longitud, sépalos 5, de 1,5-1,9 mm de largo, anchamente ovados, el ápice obtuso, glabros externamente, el margen conspicuamente ciliolado; pétalos verde-crema a crema, 5, desiguales en tamaño, los 3 externos 1,8-2,2 mm mm de largo, anchamente ovados, glabros, los 2 internos 0,5-0,8 mm de largo, ubicados dorsalmente sobre los filamentos, subcuadrados, glabros; estambres 5, pero solo 2 fértiles, las tecas 07-0,9 mm de largo, los estaminodios 1,1–1,3 mm de largo, subcuadrados, glabros, ovario 0,3–0,4 mm de largo, glabro. Frutos 1,2-1,5 × 1–1,2 cm, subglobosos, rojizos o blanco-rojizos al madurar.

Distribución, habitat y ecología.—Honduras, Costa Rica y Panamá, en bosques muy húmedos, bosques nubosos y formaciones de roble (*Quercus* sp., Fagaceae), en elevaciones de 2250–3300 m. Especímenes con flores han sido recolectados entre octubre y marzo. Frutos se han observado intermitentemente durante todo el año.

En la descripción de *Meliosma hartshornii*, Gentry (1986) comentó que ese taxón estaba cercanamente relacionado con *M. irazuensis* Standl., de la cual difería por las flores pediceladas (vs. sésiles), así como inflorescencias más anchas, con las ramas laterales menos aglomeradas y pubescencia diferente. El estudio de dichos caracteres en las colección tipo, colecciones adicionales y observaciones en el campo, han puesto de manifiesto que las flores en una misma rama, pueden ser sésiles, subsésiles o cortamente pediceladas, con pedicelos que no exceden (cuando presentes) 1,3 mm de longitud. Las inflorescencias inmaduras tienen un indumento denso, el cual llega a ser insignificante con el desarrollo de la inflorescencia. Finalmente, el especimen tipo de *M. irazuensis* tiene un indumento similar al encontrado en algunos especimenes de *M. hartshornii*. Ante la inconsistencia de los caracteres utilizados para separar ambos taxa, *M. hartshornii* se propone como sinónimo, en virtud que sus hojas, inflorescencias y flores coinciden dentro del rango morfológico señalado para *M. irazuensis*.

Esta especie era anteriormente conocida solo de Costa Rica y Panamá (Morales 2003), pero es reportada por primera vez para Honduras, basado en colecciones realizadas en el departmento de Lempira, lo que incrementa a cinco el número de especies de *Meliosma* presentes en Honduras (Morales & Nelson, datos sin publicar).

Especímenes adicionales examinados. **HONDURAS. Lempira:** campamento Naranjo, al SE de Gracias, parque nacional de Celaque, 31 ene 1992 (fr), *Mejía 21* (EAP, INB, MO, TEFH).

AGRADECIMIENTOS

Quiero agradecer a los siguientes herbarios por permitir el estudio de sus colecciones: COL, CR, DUKE, EAP, F, HUA, JAUM, LAGU, MEDEL, MHES, MO, NY, TEFH, W. De igual forma, agradezco las facilidades brindadas por Cirilo Nelson (TEFH) para el estudio de especimenes en Honduras.

REFERENCIAS

Arbeláez, A.L. 2004. Two new species of *Meliosma* (Sabiaceae) from Bolivia. Novon 14:12–16.

Aymard C., G. & N. Cuello.1994. *Meliosma gentryi* Aymard & Cuello (Sabiaceae) una nueva especie para la flora de la Guayana venezolana. BioLlania 10:1–3.

Aymard C., G. & N. Cuello. 2005. Sabiaceae. En: J.A. Steyermark, P. Berry & B. Holst, eds. Flora of the Venezuelan Guayana. Timber Press; Missouri Botanical Garden, Portland; St. Louis, Estados Unidos. 9:39–43.

Cornejo, X. & C. Bonifaz. 2006. *Meliosma stellata*, una nueva especie de Sabiaceae de Ecuador. Novon 16: 328–330.

Cuatrecasas, J. 1988. Miscellaneous notes on neotropical flora XVII. New species of *Meliosma*. Phytologia 64:489–494.

Cuatrecasas, J. & J. M. Idrobo.1988. Tres nuevas especies de *Meliosma* Blume (Sabiaceae) de Colombia. Ernstia 49:8–14.

Gentry, A.H. 1980. Sabiaceae. En: R. Woodson, R. Schery, et al., eds. Flora of Panama. Ann. Missouri Bot. Gard. 67:949–963

Gentry, A.H. 1986. New neotropical species of *Meliosma* (Sabiaceae). Ann. Missouri Bot. Gard. 73:820–824.

Gentry, A.H. 1992. Four new species of *Meliosma* (Sabiaceae) from Peru. Novon 2:155–158.

Gentry, A.H. 2001. Sabiaceae. En: W. Stevens, C. Ulloa, A. Pool & O. Montiel, eds. Flora de Nicaragua. Monogr. Syst. Bot. Missouri Bot. Gard. 85:2303–2306.

Kubitzki, K. 2004. Sabiaceae. En: N.P. Smith et al., eds. Flowering plants of the neotropics. Princenton University Press, Princeton, New Jersey, Estados Unidos. Pp. 335–336.

Kubitzki, K. 2006. Sabiaceae. En: K. Kubitzki, ed. The families and genera of vascular plants. Volume IX. Flowering plants. Eudicots. Berberidopsidales, Buxales, Crossosomatales. Springer, Berlín, Alemania. Pp. 413–417.

MEnjivar, J., G. Cerén & J.F. Morales. 2008. Sinopsis del género *Meliosma* (Sabiaceae) en El Salvador. Anales Jard. Bot. Madrid 65:389-392.

Morales, J.F. 2003. Sinopsis del género *Meliosma* (Sabiaceae) en Costa Rica y Panamá, con 3 nuevas especies. Sida 20:931–943.

Steyermark, J. & A.H. Gentry. 1992. Sabiaceae. En: G. Morillo, ed. Flora de Venezuela 5(1):221–267.

Van Beusekom, C.F. 1971. Revision of *Meliosma* (Sabiaceae), section *Lorenzanea* excepted, living and fossil, geography and phylogeny. Blumea 19:355–529.

ESTUDIOS EN LAS APOCYNACEAE NEOTROPICALES XXXVII: MONOGRAFÍA DEL GÉNERO *RHABDADENIA* (APOCYNOIDEAE: ECHITEAE)

J. Francisco Morales

Instituto Nacional de Biodiversidad (INBio), Apto 22--3100
Santo Domingo de Heredia, COSTA RICA
fmorales@inbio.ac.cr

RESUMEN

Se presenta una monografia del género *Rhabdadenia* (Apocynoideae: Echiteae). En total, tres especies son aceptadas (*R. biflora* (Jacq.) Müll.Arg., *R. madida* (Vell.) Miers y *R. ragonesei* Woodson), incluyendo una clave, descripciones completas, ilustraciones y listado de especímenes examinados para todos los taxones. Los cambios taxonómicos más notorios se refieren a la ubicación de *Rhabdadenia macrostoma* (Benth.) Müll.Arg. y *R. pohlii* Müll.Arg. bajo la sinonimia de *R. madida*, así como la designación de lectotipos para *E. biflorus* Jacq., *E. madidus* Vell., *R. lindeniana* Müll.Arg., *R. pohlii* Müll.Arg. y *R. pohlii* Müll.Arg. var. *suberecta* Müll.Arg., y la selección de un neotipo para *Echites ehrenbergii* Schltdl.

Palabras Clave: Apocynaceae, Apocynoideae, Echiteae, *Rhabdadenia*, *Echites*

ABSTRACT

A monograph of the genus *Rhabdadenia* (Apocynoideae: Echiteae) is here presented. Three species are accepted (*R. biflora* (Jacq.) Müll.Arg., *R. madida* (Vell.) Miers, and *R. ragonesei* Woodson), and a key, descriptions, illustrations, and a list of specimens examined are included. *Rhabdadenia macrostoma* (Benth.) Müll.Arg. and *R. pohlii* Müll.Arg. are placed in synonymy of *R. madida*. Lectotypes are selected for *E. biflorus* Jacq., *E. madidus* Vell., *R. lindeniana* Müll.Arg., *R. pohlii* Müll.Arg., and *R. pohlii* Müll.Arg. var. *suberecta* Müll.Arg. and a neotype is chosen for *Echites ehrenbergii* Schltdl.

Key Words: Apocynaceae, Apocynoideae, Echiteae, *Rhabdadenia*, *Echites*

Rhabdadenia Müll.Arg. es un pequeño género de tres especies distribuido prácticamente en todas las áreas tropicales y subtropicales del continente americano, desde el S de Florida (Estados Unidos) y las Antillas hasta el N de Argentina (excepto Chile), con una de las distribuciones geográficas más amplias de las Apocynoideae Neotropicales, compartida únicamente por los géneros *Forsteronia*, *Mandevilla*, *Mesechites*, *Odontadenia*, *Prestonia* y *Tabernaemontana* (Hansen 1985; Leeuwenberg 1994 a; Morales 1998, 1999; Woodson 1936). Este género fue descrito por Müller (1860 a), quien describió una especie, *R. pohlii*, incluyendo tres nuevas variedades, y transfirió otra previamente tratada en el englobador género *Echites* (*E. biflorus* Jacq.). En un trabajo subsecuente y publicado casi en forma simultánea el mismo Müller (1860 b), transfirió *E. macrostomus* Benth. a *Rhabdadenia* y publicó tres taxones adicionales (*R. cubensis* Müll.Arg., *R. lindeniana* Müll.Arg. y *R. wrigthiana* Müll. Arg.), aumentando el número de especies en el género a seis. Posteriormente Miers (1878) describió o transfirió diferentes taxones descritos en otros géneros a *Rhabdadenia* y aceptó un total de 11 especies. Finalmente Woodson (1936), clarificó y definió mejor los límites genéricos, reconociendo un total de tres especies, número que se incrementó a cuatro con la descripción de *R. ragonesei* ligeramente más tarde (Woodson 1940). Continuando con la actualización de monografías de los géneros de las tribus Echiteae y Mesechiteae (Apocynaceae, Apocynoideae), se presenta a continuación una revisión del género *Rhabdadenia*.

MORFOLOGÍA

Hábito.—Las especies de *Rhabdadenia* son hierbas suberectas, escandentes o lianas, usualmente restringidas a manglares o áreas anegadas, tales como sabanas o pantanos. Aunque tanto *R. biflora* como *R. ragonesei* son consistentemente lianas, una alta variación en relación al hábito está presente en *R. madida*, de manera que tanto formas suberectas o escandentes son encontradas en la misma población. Aunque estos extremos

J. Bot. Res. Inst. Texas 3(2): 541 – 564. 2009

de variación pueden ser totalmente diferentes, la morfología floral es prácticamente la misma. La misma variación está presente en algunas especies de otros géneros de las Apocynoideae, como *Mandevilla*, donde algunas especies como *M. pentlandiana* (A. DC.) Woodson (Ezcurra 1981) y *M. sancta* (Stadelm.) Woodson pueden comportarse como lianas o arbustos erectos, incluso en la misma población y localidad (como en Morro del Chapeu, Bahia, Brasil). Por lo tanto, el reconocimiento de variedades basado en este carácter no es aceptable.

Tallos.—Los tallos son algo aplanados en ramas jóvenes, volviéndose cilindricos o subcilindricos con la edad. Los coléteres son glándulas secretoras (Fahn 1979) que son comunes a muchos miembros de las Echiteae. En Rhabadenia los coléteres interpeciolares son diminutos y rápidamente deciduos, por lo que siempre están ausentes en tallos maduros; aunque en *R. biflora* son inconspicuos, en *R. madida* son relativamente conspicuos en tallos jóvenes (Fig. 1A). Por otro lado, los coléteres intrapeciolares son diminutos e inconspicuos y están presentes en la base del pecíolo. La presencia de coléteres intra e interpeciolares han sido utilizados en algunos casos para separar géneros (e.g., Woodson 1933; Simões & Kinoshita 2002; Morales 2005), ya que mientras en algunas especies de géneros de las Mesechiteae éstos llegan a desarrollarse notablemente (e.g., *Mandevilla, Mesechites*), en muchos otros géneros de las Echiteae éstos son inconspicuos. Al cortar los tallos, ramitas y en general cualquier parte de la planta, se da la presencia de secreción lechosa. Es importante tomar en cuenta que aunque el tipo de secreción (lechosa vs. acuosa) ha sido considerado un carácter de relativa importancia taxonómica en las Apocynoideae (Mesechiteae y Echiteae), y que si bien puede ser constante en varios grupos, existen otros géneros donde a pesar de la prevalencia de secreción lechosa (como *Mandevilla*) existen especies con secreción acuosa (e.g., *Mandevilla eximia* (Hemsl.) Woodson) y incluso géneros (como *Echites*), donde algunas especies tienen secreción acuosa (*E. puntarenense* J.F. Morales) y otras lechosa (como *E. umbelatus* Jacq).

Hojas.—Las hojas son pecioladas, con los pecíolos largos o muy cortos y entonces las hojas parecen subsésiles, y carecen de coléteres en el nervio central. La variación en la forma de la lámina foliar en *Rhabdadenia* es extrema y puede ser comparada con el que se presenta en algunos grupos de especies de otros géneros de las Apocynoideae, como *Echites* (e.g., *E. umbelatus* Jacq.), *Mandevilla* (e.g., *M. lancifolia* Woodson) o *Mesechites* (e.g., *M. repens* (Jacq.) Miers). Esta variación abarca tanto la morfología de la lámina foliar como la forma de la base (Fig. 2). El análisis aislado de estos extremos de variación morfológica puede llevar a la errónea conclusión de reconocer más taxones, pero un análisis integral demostrará que no son sostenibles. En términos generales, *R. ragonesei* es más estable en relación a la morfología foliar que las otras dos especies del género.

La pubescencia está usualmente ausente, si bien un indumento leve e inconspicuo puede encontrarse en *R. madida*, principalmente en la cara abaxial. La presencia o ausencia de indumento en *Rhabdadenia* no es un carácter significativo para la distinción de taxones a nivel específico. La venación secundaria está usualmente impresa, pero en forma leve, mientras que las venas terciarias usualmente no son evidentes. Asimismo, los márgenes son siempre planos, no revolutos.

Inflorescencias.—Las inflorescencias son cimas dicasiales muy reducidas (Woodson 1935 a, 1936), algunas veces con apariencia umbeliforme, usualmente con dos flores (Fig. 6A, C), pero con un rango que oscila entre una a cinco. Como en muchos otros géneros de las Echiteae, las brácteas son siempre escariosas y los pedicelos carecen de bracteolas. Los sepalos son esencialmente iguales, membranáceos, foliáceos y carecen de coléteres en la base de su cara adaxial. Tanto Müller (1860 a) como Woodson (1936) propusieron separar especies de *Rhabdadenia* (e.g., *R. madida* y *R. pohlii*) basado principalmente en el largo de los sépalos, sin embargo, se presenta una alta variación en relación al tamano y forma (Fig. 2), lo cual imposibilita usar esos caracteres para separar taxones a nivel específico. Aún más, no existe ni siquiera una correlación directa con la morfología de la lámina de las hojas, la cual varía en forma independiente.

Flores.—La corola es infundibuliforme, con la parte inferior del tubo recta y alrededor del punto de inserción de las anteras, la corola es internamente pentalobulada, con una cresta diminuta y un lóbulo diminuto sobre cada lóbulo (Fig. 3A–B); bajo este punto se puede encontrar un indumento denso de pelos más o menos

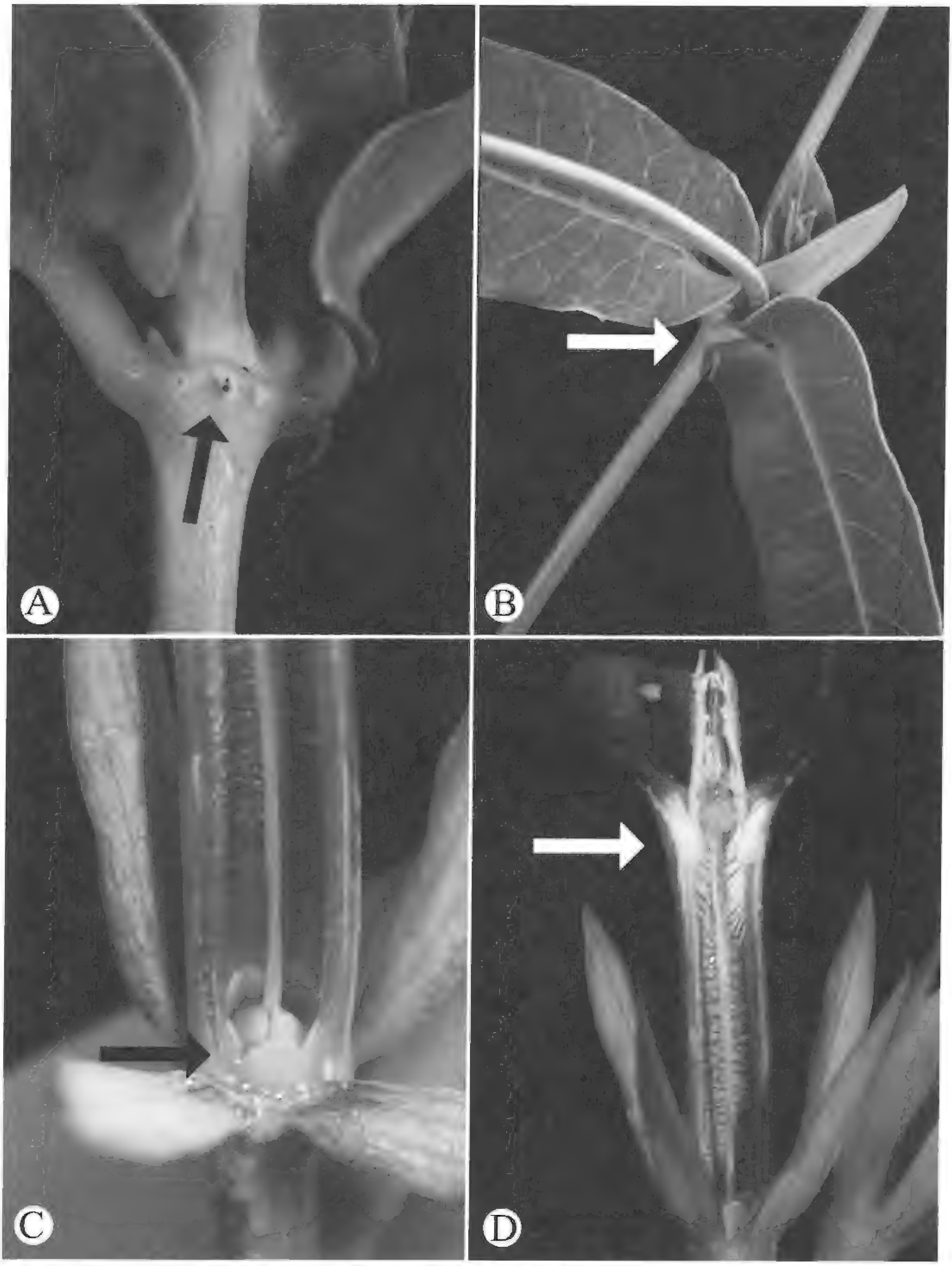


Fig. 1. Caracteres morfológicos en *Rhabdadenia madida* (señalados por una flecha). **A.** Coléteres interpeciolares. **B.** Detalle de las hojas cordadas basalmente. **C.** Nectarios y ovario. **D.** Detalle de la pubescencia infraestaminal.

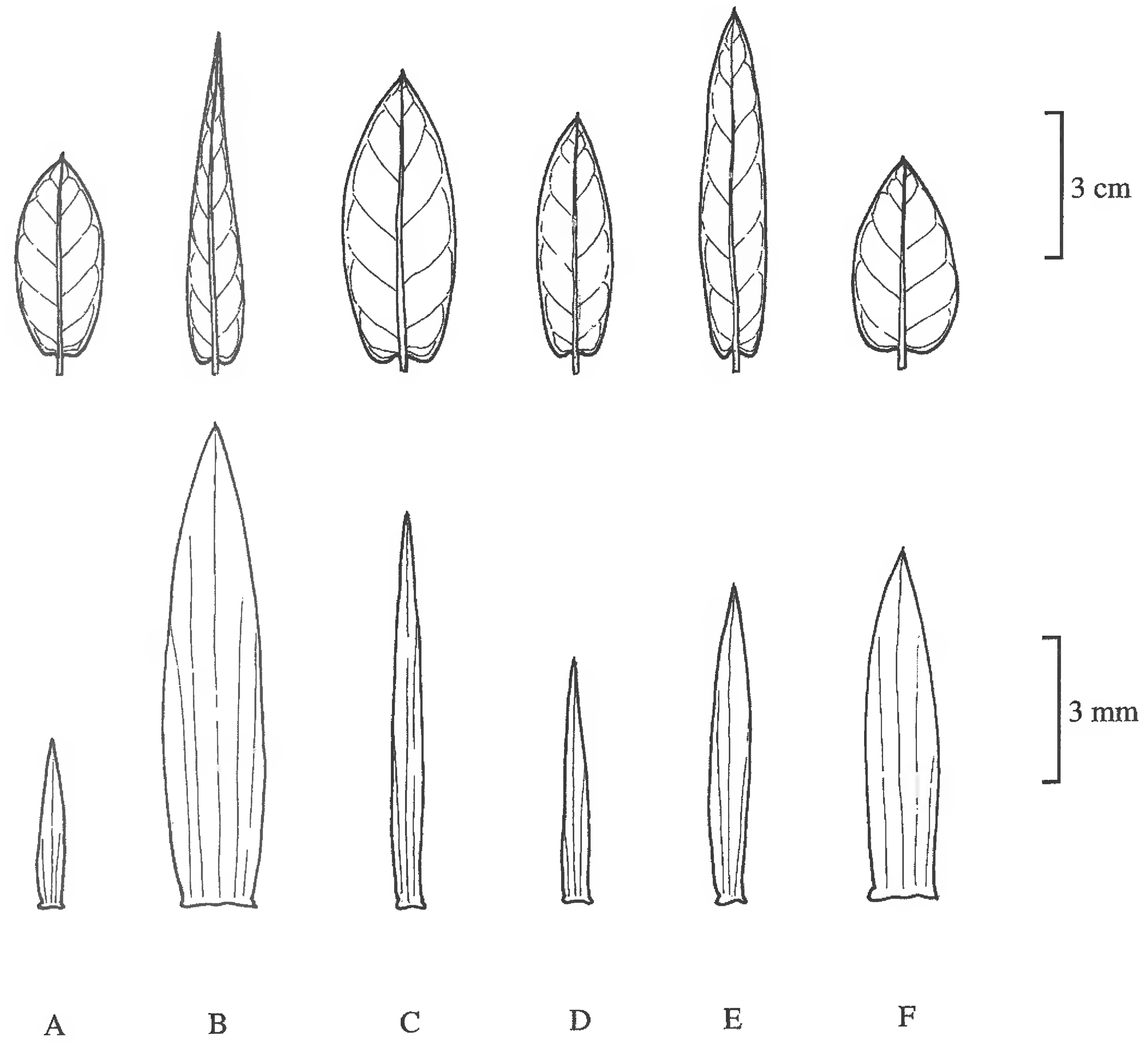


Fig. 2. Variación en la morfología de las láminas foliares y sépalos en Rhabdadenia madida. A. ***Melinon 293,*** **P. B.** ***Mereles 2146,*** **INB. C.** ***Saldias et al. 2916,*** **INB. D.** ***Toledo & Chuvé 284,*** **INB. E.** ***Zardini & Guerrero 47281.*** **F.** ***Zardini & Vieira 43854,*** **MO.**

rígidos, el cual se prolonga más o menos por un tercio dentro del tubo hacia la base (Fig. 1D). La superficie externa es usualmente glabra, aunque si bien un leve indumento de pelos simples y diminutos puede estar presente en *R. madida*. Los estambres están totalmente incluidos dentro del tubo y las anteras tienen un indumento denso en su región dorsal y apical, el cual sobrepasa el ápice (Fig. 4A). Este tipo de indumento es característico de *Rhabdadenia*, ya que mientras en otros géneros de las Echiteae (e.g., *Peltastes*, *Prestonia*) pueden presentar indumento en las anteras de algunas especies, éste usualmente se encuentra restringido a la mitad basal y no a la región apical. Las anteras están unidas a la cabeza estigmática en la región del anillo membranoso basal, por una agrupación de pelos en forma de herradura (Fig. 4B), en contraposición con los miembros de las Mesechiteae, en los cuales las anteras se encuentran unidas por fusión celular a la cabeza estigmática. De igual forma, las anteras se encuentran unidas medialmente a la cabeza estigmática por un anillo de pelos corto. La cabeza estigmática es fusiforme, con un anillo membranoso conspicuo en la base y pubescente en el ápice (Fig. 4B). El ovario es invariablemente apocárpico y los carpelos se hallan fusionados en forma postgenital al estilo y se encuentran rodeados por cinco nectarios, los cuales usualmente no sobrepasan en longitud al ovario (Fig. 1C). Muchos otros géneros de las Echiteae tienen nectarios anulares, los cuales pueden ser casi enteros o irregular y variadamente pentalobulados. Aunque si bien el número y

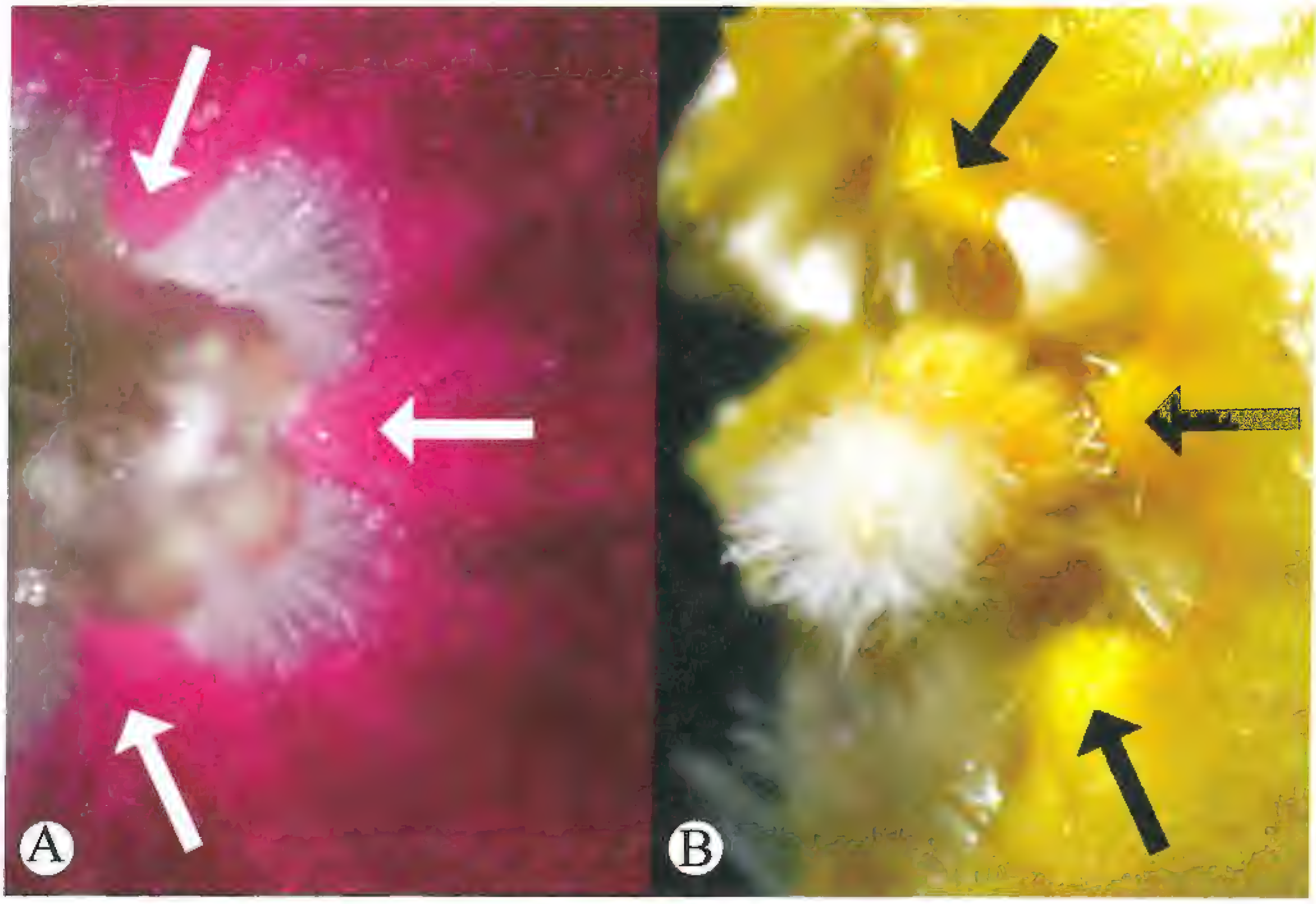


FIG. 3. Interior de la corola en *Rhabdadenia*, con los lóbulos internos en la base de las anteras (señalados con flechas). **A.** *R. madida*. **B.** *R. biflora*.

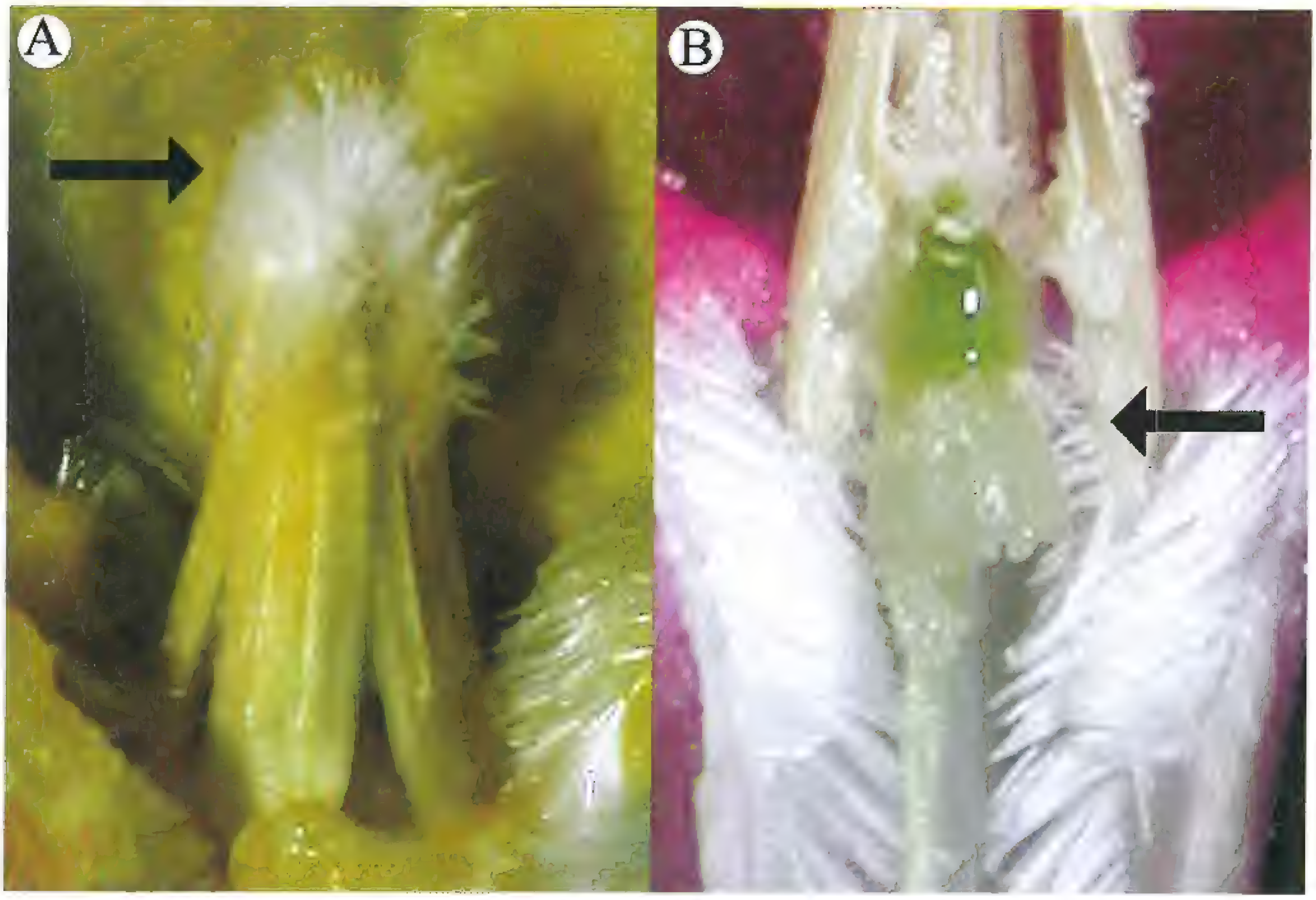


FIG. 4. Algunos caracteres del gineceo y androceo en *Rhabdadenia* (señalados con flechas). **A.** Pubescencia apical de las anteras en *R. biflora*. **B.** Detalle de los pelos que unen las anteras con la cabeza estigmática en *R. madida*.

la lobulación del nectario ha sido usado para distinción a nivel específico, es un carácter que cuya utilidad es cuestionable, dada la alta variación intraespecífica presente en algunos géneros (Morales 2004). Tanto el ovario como los nectarios carecen de un indumento visible.

Folículos.—Los folículos de *Rhabdadenia* son siempre fusiformes, continuos y algo divergentes hacia su región apical, glabros o glabrescentes, más raramente diminutamente puberulentos y son esencialmente lisos externamente, careciendo de costillas longitudinales. En forma general, en muchos géneros de las Apocynoideae los folículos están unidos en su ápice, aunque si bien en algunos pocos (e.g., *Prestonia*) folículos divaricados y divergentes están presentes en unas cuantas especies (Morales 1997; Woodson 1936). Las semillas son numerosas, rostradas y con una coma (penacho de pelos) apical, con el rostro delgado y prolongado, carácter compartido con muchos otros géneros de las Echiteae neotropicales. Algo peculiar para este género es que el rostro de la semilla se prolonga más alla del punto de donde nace la coma en el extremo micropilar, de manera que este se extiende de manera muy fina casi hasta el extremo terminal y distal de la coma. En la mayoría de los géneros de las Echiteae y Mesechiteae, la coma nace aproximadamente de un mismo punto, independientemente de que la semilla sea rostrada o truncada. A través de las descripciones, las medidas de las semillas abarcan desde el ápice chalazal hasta el punto donde nace la coma en el extremo micropilar, por lo tanto, no incluyen la prolongación del extremo micropilar más alla de este punto.

Relaciones intergenéricas.—En la clasificación de las Apocynaceae propuesta por Endress and Bruyns (2000), Apocynaceae y Asclepiadaceae fueron tratados de nuevo como un solo grupo taxonómico. En este sistema de clasificación, *Rhabdadenia* fue ubicada en la subfamilia Apocynoideae, tribu Echiteae, grupo conformado por cerca de 22 géneros de los cuales 19 están restringidos al Neotrópico (Endress & Bruyns, 2000). Otros sistemas propuestos anteriormente solo trataron los géneros de las Apocynaceae s. str. (e.g., Leeuwenberg 1994b; Pichon 1948a, 1948b, 1948c, 1949, 1950 a, 1950b) y agruparon a *Rhabdadenia* con algunos de los géneros de la tribu *Echiteae* sensu Endress and Bruyns (2000). En el sistema propuesto por Endress and Bruyns (2000), algunas inconsistencias en la conformación de los miembros de las diferentes tribus han sido corregidas en forma paulatina en los últimos años (e.g., Simões et al. 2004, 2006, 2007). Finalmente, en forma más reciente, Endress et al. (2007) propusieron nuevas modificaciones que implicaron la transferencia de cinco géneros a otras tribus (*Amalocalyx* Pierre [Apocyneae], *Cycladenia* Benth. [Odontadenieae], *Neobracea* Britton [Malouetieae], *Pottsia* Hook. & Arn. [Apocyneae], *Stipecoma* Müll.Arg. [Odontadenieae]) y la inclusión de 3 géneros recientemente descritos (*Bahiella* J.F. Morales, *Thoreauea* J. K. Williams) o que habían sido reducidos a la sinonimia (*Rhodocalyx* Müll.Arg.), de manera que la tribu Echiteae quedó conformada por un total de 20 géneros, 17 de ellos Neotropicales.

A pesar de que se han ido conformando grupos más naturales, todavía falta trabajo por hacer, sobre todo en definir las posible relaciones intergenericas prevalecientes en algunas tribus (como en Echiteae) y establecer la conformación definitiva de otras. De hecho, algunos géneros de la tribu Echiteae se han separado en forma tradicional por solo un carácter morfológico (como *Echites* y *Fernaldia*) y estudios filogenéticos basados en indicadores moleculares y caracteres morfológicos (e.g., Livshultz et al. 2007) han mostrado que algunos deben ser reducidos a la sinonimia, apoyando lo sugerido en forma previa por otros autores (e.g., Williams 2004).

Existen pocos estudios filogenéticos que traten parcial o totalmente los miembros de las Echiteae, por lo que las afinidades intergénericas de los miembros de la tribu no son claras. Algunos de estos estudios filogenéticos no han incluido *Rhabdadenia* (e.g., Williams 2004), mientras que los resultados de un análisis filogenético basado en caracteres morfológicos de los miembros neotropicales de las Echiteae (Morales 2006) sugiere que prevalece una alta homoplasia y que por el momento, son necesarios estudios moleculares para poder tener mas evidencias y determinar con más certeza las relaciones intragenéricas prevalecientes. En forma más reciente, Livshultz et al. (2007) realizaron un estudio filogenético basado en indicadores moleculares y caracteres morfológicos y sugieren que *Rhabdadenia* conforma una politomía con algunos miembros de las Apocynoideae (clado del Nuevo Mundo [New World Clade] fide Livshultz et al. 2007) y un clado compuesto por miembros de las subfamilias Asclepiadoideae y Secamonoideae.

A nivel morfológico, *Rhabdadenia* se puede reconocer del resto de géneros de las Apocynoideae por la siguiente combinación de caracteres: habitat usualmente restringido a zonas anegadas estacionalmente o manglares, tallos con coléteres interpeciolares rápidamente deciduos y pareciendo ausentes, hojas eglandulares, inflorescencias cimosas, de apariencia umbeliforme y con 1 a 4 flores, sépalos eglandulares, sin coléteres en la base de la cara adaxial, anteras con indumento en la porción apical, nectario compuesto por cinco glándulas individuales, y folículos usualmente divergentes en su región apical, con semillas rostradas.

Notas sobre el tratamiento taxonómico.—Para cada especie y para cada país solo se citan tres especímenes representativos por cada unidad geográfica (i.e., Provincia, Departamento, Estado), pero un listado completo del material estudiado se cita al final. Los usos mencionados en algunas especies han sido tomados directamente de las etiquetas de herbario, tal y como han sido citados por cada colector, por lo tanto, no ha sido posible verificar su efectividad. Las distintas partes de las corolas (tubo basal y superior) siguen lo descripto por Ezcurra (1981), Morales & Fuentes (2004) y Simões & Kinoshita (2002).

TRATAMIENTO TAXONÓMICO

Rhabdadenia Müll.Arg., Fl. Bras. 6(1):173. 1860. Tipo: *Rhabdadenia pohlii* Müll.Arg. (Lectotipo, designado por Britton & Millspaugh 1920).

Lianas o hierbas suberectas, tallos con secreción lechosa, glabros o glabrescentes a puberulentos, aplanados cuando jóvenes, volviéndose subcilíndricos o cerca de eso con la edad, coléteres interpeciolares no evidentes, coléteres intrapeciolares inconspicuos. Hojas opuestas, raramente algún nudo con hojas verticiladas, eglandulares, sin coléteres en el nervio central adaxialmente, usualmente glabras, raramente puberulentas en la superficie abaxial, membranáceas, sin domacios, márgenes no revolutos, pecioladas a subsésiles. Inflorescencias cimas reducidas, con menos de 5 flores, usualmente solo 2 ó 3 presentes, axilares o subterminales, glabras o inconspicuamente puberulentas, brácteas escariosas e inconspicuas, bracteolas ausentes; cáliz con 5 sépalos esencialmente iguales, diminutos a foliáceos o subfoliáceos, glabros o puberulentos en la superficie externa, el ápice no reflejo, sin coléteres en la base de la cara adaxial; corola infundibuliforme, internamente pentalobulada, con una cresta y un lóbulo diminuto sobre cada lóbulo alrededor del punto de inserción de las anteras, púrpura, rosada, blanco-rosada a blanca, raramente roja, usualmente glabra en la superficie externa, con numerosas y conspicuas venas longitudinales, el tubo recto, limbo con 5 lóbulos, con estivación dextrorsa; estambres incluidos, insertos en la base de la parte superior del tubo, anteras conniventes y aglutinadas a la cabeza estigmática, la base no auriculada, filamentos inconspicuos o no evidentes, cabeza estigmática con un anillo membranoso conspicuo en la base y la parte distal más o menos fusiforme, pubescente en el ápice; gineceo bicarpelar, apocárpico, con numerosos óvulos, nectarios 5, separados o irregularmente connados basalmente y formando un nectario pentalobulado. Frutos dos folículos apocárpicos, fusiformes, rígidos y más o menos paralelos entre sí, continuos, membranáceos, no fusionados longitudinalmente, los ápices generalmente divergentes; semillas numerosas, rostradas, comosas en el extremo micropilar, el extremo micropilar prolongándose más alla del punto de inserción de la coma, en forma de una cerda inconspicua.

Género con tres especies distribuidas desde el SE de Estados Unidos (Estado de Florida) hasta el N de Argentina (excepto Chile) y las Antillas.

CLAVE PARA LAS ESPECIES DE *RHABDADENIA*

1. Parte inferior del tubo 31–34 mm de largo; brácteas florales 8–11 mm de largo ____ **R. ragonesei**
1. Parte inferior del tubo (6–)8–20 mm de largo; brácteas florales 1–6,5 mm de largo.
    2. Corola con la parte superior del tubo obcónica; lóbulos de la corola blancos, blanco-rosados o rosado pálido; brácteas florales 1–1.8 mm de largo; parte inferior del tubo 12–20 mm de largo; lámina foliar con la base la base obtusa o cuneada; pecíolo 6–18 mm de largo ____ **R. biflora**
    2. Corola con la parte superior del tubo cilíndrico-campanulada; lóbulos de la corola púrpura, rosados, rosado intenso a raramente rojos; brácteas florales 3.5–6.5 mm de largo; parte inferior del tubo (6–)8–12 mm de largo; lámina foliar con la base la base cordada, subcordada a redondeada o subtruncada; pecíolo 2–5(–6) mm de largo ____ **R. madida**

1. Rhabdadenia biflora (Jacq.) Müll.Arg., Fl. Bras. 6(1):175. 1860. (**Figs. 3B, 4A, 5 y 6A–B**). *Echites biflorus* Jacq., Enum. Syst. Pl. 13. 1760. Tipo: T. 96 en Plumier, Descr. Pl. Amer. 1693 (lectotipo, designado aquí).

Echites paludosus Vahl, Eclog. Amer. 2:19. 1798. *Exothostemon paludosum* (Vahl) G. Don, Gen. Syst. 4:83. 1838. *Rhabdadenia paludosa* (Vahl) Miers, Apocyn. S. Amer.: 119. 1878. Tipo: TRINIDAD: datos perdidos (fl), *von Rohr 21* (holotipo: C [2 cartulinas])

Echites ehrenbergii Schltdl., Linnaea 26:666. 1853. *Rhabdadenia ehrenbergii* (Schltdl.) Müll.Arg. ex Griseb. Fl. Br. W. I. 415, Linnaea 30:454. 1860. Tipo: REPÚBLICA DOMINICA: Santo Domingo, fecha perdida, *C. Ehrenberg s.n.* (no localizado). Barahona: Micre, 1910 (fl), *Fuertes 220* (neotipo: designado aquí, US; isoneotipos: MO, P, U, W).

Dipladenia billbergii Beurl., Kongl. Vetensk. Acad. Handl. 40:137. 1854 [1856]. Tipo: PANAMÁ. Colón: Portobello, abr 1826 (fl), *Billberg 254* (holotipo: S).

Rhabdadenia nervosa (Mill.) Miers, Apocyn. S. Amer.: 122. 1878. *Apocynum nervosum* Mill., Gard. Dict. (ed. 8) n. 9. 1768. Tipo: COLOMBIA. Atlántico: Cartagena, sin fecha (fl), *Miller s.n.* (holotipo: BM).

Rhabdadenia cordata (Mill.) Miers, Apocyn. S. Amer.: 122. 1878. *Apocynum cordatum* Mill., Gard. Dict. (ed. 8) n. 10. 1768. Tipo: MÉXICO. Veracruz: datos perdidos (fl), *Miller s.n.* (holotipo: BM).

Rhabdadenia macrantha Donn. Sm., Bot. Gaz. 40:7. 1905. Tipo: HONDURAS. Cortez: Puerto Sierra, ene 1903 (fl), *Wilson 244* (holotipo: US; isotipo: NY).

Lianas o arbustos escandentes, tallos glabros a glabrescentes. Hojas con el pecíolo 6–18 mm de largo, láminas (2.7–)3–11.2 × 0.5–4.2 cm, angostamente elípticas, elípticas, linear-elípticas a obovado-elípticas, más raramente lineares, el ápice obtuso-mucronado a agudo-mucronado, la base obtusa o cuneada, glabras, las venas secundarias usualmente impresas, aunque a veces algo inconspicuas, venas terciarias evidentes o no evidentes. Inflorescencia con 1 a 3(5) flores, usualmente glabra, pedúnculo 1.7–6.8(–8.4) cm de largo, pedicelos 12–21 mm de largo, brácteas 1–1.8 × 1–1.3 mm, angostamente ovadas; sépalos (1.5–)2–11 × 0.8–3.5 mm, ovados, ovado-elípticos, el ápice agudo a agudo-mucronado u obtuso-mucronado, foliáceos o subfoliáceos, más raramente diminutos, glabros externamente; corola con el tubo blanco en su parte externa, los lóbulos blancos, blanco-rosados o rosado pálidos, parte inferior del tubo 12–20 × 2–3.5 mm, la parte superior obcónica, 19–28 mm de largo, con un diámetro de 1.3–1.6 cm en la boca, el ápice del botón floral apiculado o cortamente acuminado, lóbulos 1.9–2.4 × 1.4–2.1 cm, obovados; anteras 4.1–4.7 mm de largo, glabras dorsalmente, excepto por la pubescencia apical, la base truncada; ovario 1.2–1.6 mm de largo, glabro, cabeza estigmática 1.4–1.7 mm de largo, nectarios 1/2–2/3 de la longitud total del ovario, libres o algunos de ellos irregularmente connados basalmente. Folículos 9.1–18.2 cm × 1.5–4.5 mm, glabros; semillas 2.4–4.1 cm de largo, glabras, la coma 3–4.1 cm de largo, color crema.

Distribución, habitat y ecología.—S de Estados Unidos (estado de Florida) a través de Mesoamérica hasta el N de Ecuador y el N de Brasil y las Antillas, donde crece en manglares o formaciones vegetales asociadas, en elevaciones de 0–10 m. Especímenes con flores y frutos han sido recolectados durante todo el año, pero las flores son más abundantes durante el período de lluvias.

Nombres comunes y usos.—“bejuco lechero” (Venezuela, Monagas); “cai seca” (Brasil, Pará, Marajó); “cipó de carangrejo” (Maranhao, río Maracassumé); “dub inanusu” (Panamá, San Blas, Isla Urbili, nombre Kuna); “lecho de mar” (Colombia, Nariño, Tumaco); “liane mangle” (Guyana Francesa, Cayenne, Mahury); “mangrove vine” (Belize, Belize city); “palo de leche” (República Dominicana). Esta especie ha sido usada como destumescente, mediante un baño con decoción y aplicándola sobre el área afectada (*Arvigo et al. 365*, MO, NY). También ha sido usada en baños contra dolores de cabeza y mareos.

Rhabdadenia biflora es la especie más ampliamente distribuida del género y se puede reconocer fácilmente por la siguiente combinación de caracteres: hojas conspicuamente pecioladas, con los pecíolos usualmente de 17–84 mm de largo, y corolas con la parte inferior del tubo de 12–20 mm de longitud, la parte superior obcónica. Aunque en términos generales y sobre todo, comparándola con la alta variación intraespecífica presente en *R. madida*, *R. biflora* es relativamente estable en cuanto a la variación morfológica de los hojas, la misma variabilidad en en el tamaño, forma y longitud de los sépalos presente en *R. madida* se encuentra en este taxón. De esta manera, aunque es común que los sépalos usualmente sobrepasen los 4 mm de largo, se pueden encontrar numerosos especímenes, sobre todo provenientes de las Antillas, donde los sépalos raramente sobrepasan los 3 mm de longitud, encontrandose en un rango de 1.5–2.5 mm. El pretender reconocer estos especímenes como un taxón aparte no parece correcto, por que no existen diferencias adicionales en el resto de caracteres morfológicos que puedan justificarlo, aún a nivel de variedad.

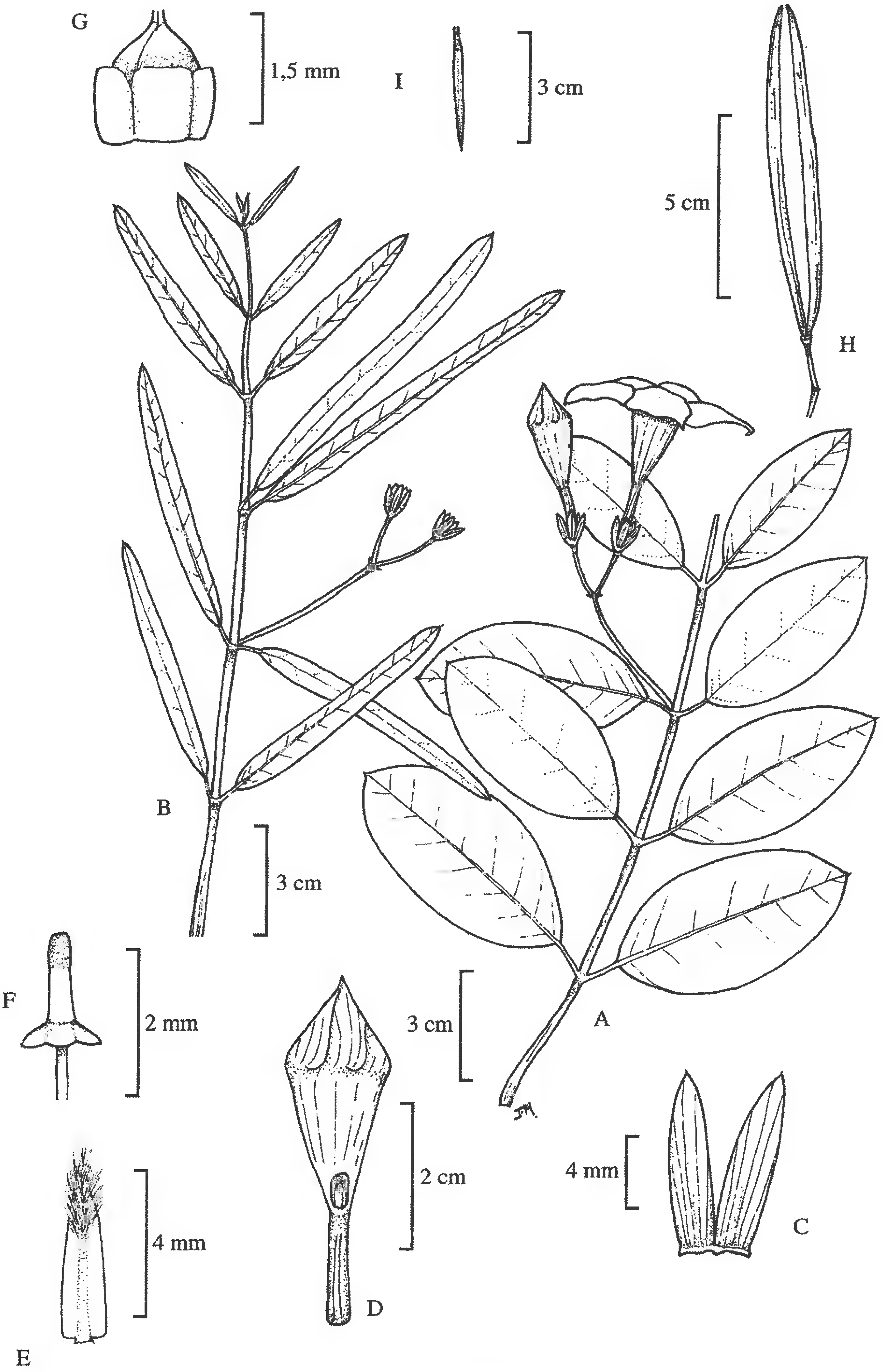


Fig. 5. *Rhabdadenia biflora* (A de *Aguilar 6205,* INB; B–G de *Morales 3010,* INB; H–I de *Cedillos 3371,* INB). **A.** Ramita con inflorescencias. **B.** Ramita con inflorescencias. **C.** Vista de la cara adaxial de dos sépalos, mostrando la ausencia de coléteres en la base. **D.** Tubo de la corola parcialmente abierto, mostrando la posición de las anteras. **E.** Antera, vista dorsal. **F.** Cabeza estigmática. **G.** Nectarios y ovario. **H.** Folículos. **I.** Semilla.

Se designa un neotipo para *Echites ehrenbergii* Schltdl., dado que la única colección citada en la descripción original (*C. Ehrenberg s.n.*) no fue localizada. Es probable que este espécimen haya sido destruido en Berlín durante la Segunda Guerra Mundial. En la monografía de Woodson (1936), se citó *Echites billbergii* Beurl. como un sinónimo de *R. biflora*; sin embargo, en la publicación original (Beurling 1856), dicho taxón fue descrito como *Dipladenia* (*Echites*?) *billbergii*, por lo cual es citado de manera correcta acá.

Especímenes representativos examinados: **ESTADOS UNIDOS. Florida:** Collier County, Royal Palm Hammock, 27 jul 1966 (fl), *Almeda & Lakela 285* (US, USF); Miami, jun 1880 (fl, fr), *Curtiss 2266* (BR, LV, P, US); cerca de Brickell Hammock, Dade, 4 mar 1930 (fl), *Moldenke 725* (MO, NY, US). **MÉXICO. Campeche:** Champotón, 7 jul 1932 (fl), *Steere 1910* (MO); Calkiní, carretera a Isla Arena, 28 nov 1993 (fl, fr), *Tun et al. 126* (CICY, W). **Quintana Roo:** N de Punta Celarain, camino a Laguna Colombia, isla Cozumel, 10 jul 1984 (fl), *Cabrera & Cabrera 6762* (MEXU, MO); Puerto Morelos, S de Xel-ha, 6 may 1980 (fl), *Téllez 2050* (MEXU, MO); Vigía Chico, 11 may 1980 (fl), *Téllez 2238* (MEXU, MO). **Tabasco:** carretera Mecoacan-Chiltepec, 23 ago 1981 (fl), *Magaña & Zamudio 309* (MO); Centla, al S de Puerto San Pedro, Laguna El Cometa, 24 sep 1998 (fl), *Novelo & Ramos 3105* (MO); Centla, laguna Pez Espada, 14 dic 1998 (fl), *Novelo & Ramos 3618* (MO). **Veracruz:** cerca de la Laguna de la Mancha, 20 jun 1972 (fl), *Dorantes et al. 1201* (MEXU, U); Laguna de Sontecoma, Catemaco, 25 feb 1973 (fl), *Menéndez 97* (MEXU, MO); Coatzacoalcos, istmo de Tehuantepec, 12 ene 1895 (fl), *Smith 1080* (EAP). **Yucatán:** Puerto Silam, 1895 (fl), *Gaumer 653* (US); Lagoon shores, Las Bocas del Silam, may 1916 (fl), *Gaumer 23335* (EAP, F, MO, US); S de El Progreso, 23 mar 1970 (fl), *Utley 39* (MO, USF, WAG). **BELICE. Belice:** ciudad Belice, northern highway, 30 mar 1990 (fl), *Arvigo et al. 365* (MO, NY); St. Johns Collage, 15 mar 1967 (fl, fr), *Dwyer et al. 11* (MO); entre ciudad de Belice y Ladyville, 9 ago 1992 (fl), *Worthington 21223* (MO, UTEP). **Corozal:** cercanías de Little Belice, 17 mar 1987 (fl), *Davidse & Brant 32588* (MO); entre Sarteneja y Chunox, 18 mar 1987 (fl), *Davidse & Brant 32622* (MO). **Stann Creek:** point Placencia, 30 dic 1985 (fl, fr), *Walter 1107* (MO). **Toledo:** río Monkey, 1 dic 1941 (fl), *Gentle 3826* (MO, US). **GUATEMALA. Izabal:** Puerto Berrios, 2 abr 1922 (fl, fr), *Greenman & Greenman 5986* (EAP, MO); Machacas, biotopo Chocón, 6 mar 1993 (fl), *Pöll et al. s.n.* (INB, UVAL); Livingston, Laguna Escondida, 28 jul 1988 (fl, fr), *Tenorio et al. 14941* (INB, MEXU, MO). **Petén:** San Pedro, 8 ene 1970 (fl), *Contreras 9471* (MO). **HONDURAS. Atlándida:** Laguna Los Micos, NO de Tela, 10 nov 1988 (fl), *MacDougal et al. 3435* (MO, WAG); Puerto Escondido, O de Tela, 11 feb 982 (fl), *Nelson 7854* (MO, TEFH); entre barras de Cuero y de Salado, May–Ago 1989 (fl), Soto 485 (TEFH). **Colón:** Puerto Castilla, 17–20 jul 1973 (fl), *Nelson & Martínez 1154* (EAP, TEFH); NE de Trujillo, camino viejo a Castilla, 23 sep 1981 (fl), *Saunders 619a* (MO); entre Trujillo y Castilla, 10 ene 1981 (fl), *Saunders et al. 854* (MO, TEFH). **Cortés:** playas de Tulián, 16 jun 1952 (fl), *Molina 5208* (EAP, US); entre Tulián y Cortes, 12 may 1950 (fl), *Molina 6951* (EAP); laguna de Vedián, al O de Barra de Ulúa, 26 mar 1993 (fl), *Nelson & Andino 15500* (EAP). **Gracias a Dios:** río Plátano, villa de Ras, 23 may 1973 (fl), *Gentry et al. 7553* (MO, TEFH); Tuas, O de Brus, abr 1971 (fl), *Nelson & Hernández 968* (EAP, MO); La Mosquitia, Puerto Lemira, laguna Caratasca, 17–21 jul 1977 (fl), *Nelson & Romero 4245* (EAP, TEFH). **Islas de la Bahía:** Isla de Roatán, 19 abr 1967 (fl), *Molina 20648* (EAP, US); Flowers Bay, 17 sep 1982 (fl), *Nelson 8503* (TEFH, US); Isla de Barbareta, 9 may 1984 (fl), *Nelson & Cruz 8895* (TEFH). **EL SALVADOR. La Unión:** Isla Martin Pérez, Golfo de Fonseca, 4 dic 2006 (st), *Morales 14599* (INB, MHES). **NICARAGUA. Zelaya:** Corn Island, 9 mar 1971 (fl), *Atwood 4393* (MO); cercanías de Bluefields, 13 abr 1961 (fl), *Bunting & Licht 1278* (F, US); Prinzapolka, 23 jun 978 (fl), *Neill 4563* (MO, NY). **COSTA RICA. Guanacaste:** Palo Verde, río Tempisque, 23 jun 1993 (fl), *Chavarría 823* (CR, F, INB); Punta Guiones, Península de Nicoya, 13 may 1983 (fl), *Gómez 20567* (CR). **Limón:** parque nacional Cahuita, Puerto Viejo, 6 jul 2000 (fl), *Acosta et al. 2202* (INB, MO); entre Punta Cocles y quebrada Ernesto, 2 ago 1984 (fl), *Grayum & Sleeper 3658* (CR, MO); Manglar Gandoca Manzanillo, 24 jun 1983 (fl), *Soto s.n.* (CR). **Puntarenas:** parque marino Ballena, 29 jun 1994 (fl), *Lepiz 399* (CR, INB, MO); Quepos, 7 jul 1994 (fl), *Morales 3010* (CR, INB, MO); Golfito, Golfo Dulce, mar 1896 (fl), *Pittier 9903* (BR, CR, US). **PANAMÁ. Bocas del Toro:** S de Chiriquí Grande, 25 mar 1985 (fl), *Hampshire & Whitefoord 948* (BM, MO); S de Tigre Key, 25 feb 1989 (fl), *Peterson & Annable 7129* (MO, US); Water valley, 8 nov 1940 (fl), Wedel 1546 (MO, US). **Chiriquí:** río de David, dic 1881 (fl), *Lehmann 1000* (US); Estero Rincón Largo, SSE de Horconcitos, 22 sep 1983 (fl), *Schmalzel & Stedtman 1789* (MO); San Bartolomé, Península de Burica, 28 Jul–1 ago 1940 (fl), *Woodson & Schery 933* (MO). **Colón:** Coclé del Norte, 25 ago 1978 (fl), *Hammel 4572* (MO, WAG); playa Langosta, al E de Colón, 12 ago 1979 (fl), *Meijer 332* (MO); cercanías de Palmas Bellas, 30 may 1971 (fl), *Thoms 2* (MO, PMA). **Darién:** La Miel, 18 jul 1985 (fl), *Cuadros 2239* (COL); quebrada Garey, 22 ago 1964 (fl), *McDaniel 5145* (MO); E de Santa Fé, 16 jul 1966 9fl), *Tyson et al. 4670* (MO). **Panamá:** cerca de la boca del río Chagres, 15 mar 1935 (fl), *Allen 885* (MO, P, US); entre Balboa y Chamé, 2 dic 1934 (fl), *Dodge et al. 16727* (MO); isla Barro Colorado, 16 ene 1982 (fl), *Schmalzel 316* (MO); Coco Solo, 27 sep 1972 (fl), *Tyson 6806* (TEFH). **San Blas:** entre aereopuerto de Mandinga y Cangandi, 10 dic 1985 (fl), *de Nevers et al. 6441* (MO); Mulatuppu, río Ibedi, 7 ago 1966 (fl), *Duke 8477* (MO); San Blas, 8 oct 1978 (fl), *Hammel & D'Arcy 5038* (MO). **Veraguas:** Isla de Coiba, Santa Cruz, 17 oct 1997 (fl), *Ibañez et al. 543* (MA); bahía Honda, Lerén, 7 ago 2002 (fl), *Ibañez et al. 2141* (MA); Isla de Coiba, río Santa Cruz, 21 nov 1994 (fl), *Martín-Ballesteros et al. 624* (MA). **COLOMBIA. Antioquia:** Turbó, Bocas del Atrato, Vereda Turbito, Bahia Colombia, Golfo de Urabá, 4 ago 1987 (fl), *Callejas et al. 5030* (HUA, MO); río Bohios, 29 jun 1985 (fl), *Renteria et al. 4285* (JAUM, MO); Arboletes, 30 sep 1986 (fl, fr), *Roldán et al. 516* (COL, HUA [2 cartulinas], MO, NY). **Atlántico:** Cartagena, 1805 (fl), *Bonpland 1354* (P); Barranquilla, Las Flores-La Playa, 13 sep 1959 (fl), *Cuatrecasas 24295* (INB, US); Barranquilla, ene 1928 (fl), *Elias 371* (US). **Chocó:** Bahía Solano, corregimiento El Valle, entre del Valle y Almejal, 15 abr 1989 (fl), *Espina et al. 2453* (CHOCO, HUA, INB); boca del río San Juan, 9 ene 1947 (fl), *Haught 5416* (COL, MO, US); Playa de Togoramá, 12 jun 1944 (fl), *Killip & Cuatrecasas 39078* (US, VALLE). **Magdalena:** Ciénaga, 30 mar 1942 (fl), 13 feb 1950 (fl), *Romero-Castañeda 1925* (COL, MEDEL); Santa Marta, 1898–1901 (fl), *Smith 1664* (G, NY, P, US). **Nariño:** bocas del río Sanquianga, La Tula, 12 abr 1976 (fl), *Cabrera & Escallón 4013* (CUVC); Tumaco, río Chaguí, entre Vereda

Chajal y Guadual, 16 jun 1989 (fl), *Madrigal & Mesa 661* (COL, HUA). **San Andrés:** Isla de San Andrés, 22–27 abr 1948 (fl), *Proctor 3312* (US). **Sucre:** Tolú, Arroyo Villero, carretera Tolú-Coveñas, 18 sep 1990 (fl), *Betancur & Berrio 1983* (COL, HUA, US); Islas San Bernardo, 19 ago 1979 (fl), *Bernal 133* (COL, P); San Onofre, corregimiento Salas, Arroyó Socó y manglares, 7 sep 1996 (fl, fr), *Realpe 170* (HUA). **Valle:** boca del río Yurumangui, 24 feb 1983 (fl), *Gentry & Juncosa 40726* (COL, MO); Punta Arenas, N de Buenaventura, 2 jun 1944 (fl), *Killip & Cuatrecasas 38622* (MEDEL, VALLE, US); bahía Málaga, vereda La Plata, 18 abr 1992 (fl), *Otero & Sandino 157* (CUVC). **VENEZUELA. Amazonas:** Delta del Orinoco, puerto Caripito, jun 1943 (st), *Cardona 593* (US, VEN). **Delta Amacuro:** río Amacuro, cerca de San José de Amacuro, 21 nov 1960 (fl), *Steyermark 87705* (VEN); Pedernales, boca del Caño Guiniquina, 18 oct 1977 (fl), *Steyermark & Liesner 114892* (MO, VEN); río Cuyubini, abr 1955 (fl), *Wurdack 324* (US, VEN). **Falcón:** Hacienda Guacabana, base O del cerro de Chichiriviche, parque nacional Morrocoy, 23 feb 1993 (fl, fr), *Dávila & Martín-Ballesteros 397* (MA); Silva, cerro de Chichiriviche, S de Golfete de Guare, 13 ago 2002 (fl), *Dorr & Niño 9100* (INB, US); Chichiriviche, salinas al S de la Fábrica de cemento, hasta Playa Sur, 24 sep 1993 (fl), *Martín-Ballesteros 151* (MA). **Miranda:** Paparo, boca del Río Grande, Barlovento, 11–16 jun 1913 (fl, fr), *Pittier 6352* (US); Silva, caño Ramadita, al N de Boca de Aroa, 1 sep 1974 (fl), *Steyermark & Manara 110529* (VEN); Silva, La Peñita, Golfete de Guare, 30 ago 1974 (fl), *Steyermark & Manara 110893* (VEN). **Monagas:** reserva florestal de Guarapiche, 18–20 jun 1965 (fl), *Berti 699* (VEN). **Sucre:** Península de Paria, San Juan de las Galdonas, 1995 (fl), *Allorge 1023* (P); cercanías de Cristobal Colón, 5 Ene–22 feb 1923 (fl), *Broadway 428* (GH, US); Quebrada El Purgatorio, jul 1955 (fl), *Lasser & Vareschi 3863* (VEN). **Trujillo:** Playa La Ceiba, 10 sep 1978 (fl), *Stergios 1375* (VEN). **Zuliá:** entre Río Grande y Mejillones, Península de Paria, 22 ago 1961 (fl), *Aristeguieta & Agostini 4773* (VEN); entre Santa Barbara y San Carlos del Zuliá, ensenada del Congo, 30 nov 1966 (fl), *Bruijn 1301* (U, US, WAG, VEN); entre Bella Vista y Santa Rosa, cerca Maracaibo, 7 oct 1922 (fl), *Pittier 10480* (US, VEN). **TRINIDAD:** Manzanilla, sep 1940 (fl, fr), *Baker & Broadway 412* (MO); carretera Cocos, suampo Nariva, 21 jul 1977 (fl), *Philcox et al. 8045* (K, P); Manzanilla, 12 mar 1950 (fl), *Simmuels 448* (K, MO). **PUERTO RICO:** Playa de la Carmelita, abr 1883 (fl), *Eggers 836* (BR, P [3 cartulinas], W); Bayamon, 22 mar 1885 (fl), *Sintenis 935* (S, US); Martín Peña, 25 ene 1914 (fl), *Stevenson 433* (US). **BAHAMAS:** Cerca de Providence, Lake Cunningham, 23 mar 1974 (fl), *Correll & Correll 41941* (FTG, MO); cerca de Lyford cay, Providence 14 mar 1946 (fl), *Degener 18738* (MO, US); Nueva Providencia, lago Cunningham, 11 jul 1960 (fl), *Webster et al. 10410* (US). **GRAND CAYMAN:** Sureste de Georgetown, 6 jul 1938 (fl), *Kings 199* (BM, MO); Snug Harbour, 16 jun 1974 (fl), *Stoddart 7014* (MO, US); West Bay, 17 jun 1974 (fl), *Stoddart 7039* (US). **LITTLE CAYMAN:** Suroeste de Mary's Bay, 5 ago 1975 (fl), *Proctor 35116* (US). **CUBA. Granma:** S de Manzanilla, 12 jul 1985 (fl, fr), *Gentry 51015* (MO). **Habana:** Habana, s.d. (fl), *Boldo s.n.* (MA); Vedado, 1904 (fl), *Hermann 427* (P); al N de Nueva Gerona, Isla de Pinos, 6–10 feb 1956 (fl), *Morton 10002* (US). **Isla de Pinos:** río Las Casas, cerca de Nueva Gerona, 3 feb 1953 (fl), *Killip 42583* (US); río Júcaro, 27 feb 1953 (fl), *Killip 42954* (US); camino a Bibijagua, 21 mar 1953 (fl), *Killip 43152* (US). **Matanzas:** Buena Ventura, 10 abr 1994 (fl), *Acevedo-Rodríguez et al. 6347* (US); cero de Cananova, ago 1948 (fl), *Clemente 6201* (US); entre Varadero y playa de Camarioca, 20 jun 1988 (fl), *Fernández-Casas & Morales 10638* (MA). **Oriente:** Ensenada de Mora, 26–29 mar 1912 (fl, fr), *Britton et al. 23070* (US). **Pinar del río:** cercanías de Punta de Afuera, Bahía Honda, 14 dic 1910 (fl), *Wilson 9264* (U). **Santa Clara:** Cien Fuegos, río Dauji, 23 may 1895 (fl), *Combs 78* (MO, P, US); Gavilan, jun 1941 (fl), *Howard 4941* (MO, US); Cien Fuegos, Belmonte, Soledad, 6 ago 1927 (fl), *Jack 5242* (P). **REPÚBLICA DOMINICANA. Distrito Nacional:** Santo Domingo, Maimón, jun 1887 (fl), *Eggers 2676* (P); Santo Domingo, ene 1823 (fl), *Ritter s.n.* (W). **Espaillat:** cerca de Gaspar Hernández, 5 abr 1959 (fl), *Jiménez 1959* (US). **María Trinidad Sánchez:** al S de Nagua, 20 mar 1969 (fl), *Liogier 14529* (NY, US). **Samaná:** río Barrancota, al S de Sánchez, 1 may 1921 (fl), *Abbott 1444* (US); cerca de Sánchez, península de Samaná, 24 may 1922 (fr), *Abbott 2417* (US); entre punta Jícaco y Punta Rey, 29 nov 1923 (fl), *Abbott 2847* (US). **HAITÍ. Grand Anse:** Grande Cayemite, 20 ago 1927 (fl), *Eyerdam 321* (MO, P, US); Miragoane, 15 sep 1927 (fl, fr), *Eyerdam 559* (P, US). **Nord Ouest:** cercanías de Basse Terre, Isla Tortue, 22 mar 1929 (fl), *Leonard & Leonard 13916* (US). **Ouest:** Massif de la Pelle, 5 ene 1927 (fl), *Ekman 8053* (S, US); Port au Prince, 17 may 1942 (fl), *Holdridge 1222* (MO, US); Papet, entre Leogane y Grande Goave, 6 jul 1941 (fl), *Seibert 1719* (MO, US). **JAMAICA. Clarendon:** rocky point Bay, 21 nov 1963 (fl), *Proctor 24219* (U). **Manchester:** base NO de Round Hill, 4 feb 1980 (fl), *Gentry & Kapos 28373* (MO). **Portland:** Puerto Antonio, 28 jun 1897 (fr), *Fredholm 3071* (US). **St. Andrew:** cercanía de Hunts Bay, 22 feb 1920 (fl), *Maxon & Kllip 321* (P, US). **St. Ann:** Bahía de St. Annes, 9 mar 1916 (fl), *Killip 533* (US). **St. Thomas:** entre Morant bay y Port Morant, 14 ene 1958 (fl), *Yuncker 17961* (MO). **MARTINICA:** Lamantin, río Saleé, 1883 (fl), *Duss 1867* (US); río Pilote, 14 jun 1940 (fl), *Stehlé & Stehlé 4562* (US). **GUADALUPE:** Grande Terre, petit canal, nov 1990 (fl), *Billiet & Jadin 5136* (BR); entre la Pointe Fitre y río Salec, 1893 (fl), *Duss 7* (P); Marécages, 2 feb 1939 (fl), *Questel 4188* (US). **ANTIGUA:** Millars Old Works, abr 1937 (fl, fr), *Box 576* (US). **GRENADA:** St George, dic 1887 (fl), *Eggers 6510* (P, US) **GUYANA:** Demerara-Mahaica, entre Cane Grove y Lama, 10 feb 1988 (fl), *Hahn et al. 3808* (P, U, US, WAG); río Berbice, al S de New Dageraad, 5 oct 1981 (fl), *Maas et al. 5548* (MO, P, U, WAG, VEN); Pointe Macouria, Cayenne, 21 ene 1978 (fl), *Raynal-Roques 19814* (P, U). **GUYANA FRANCESA:** Crique Malmanoury, dic 1989 (fl), *Billiet & Jadin 4734* (BR, MO); playa de Susini, entre Bourda y playa de Montjolv, 21 dic 1986 (fl), *Cremers 9523* (CAY, NY, P, U, US); Ile de Cayenne, Mahury, La Levée, 18 ene 2001 (fl), *Prévost 4103* (CAY, MO, K, P, U). **SURINAM:** Peperrot, 5 mar 1951 (fl), *Florschüt & Florschüt 1677* (BR, U); Paramaribo, 24 mar 1961 (fl), *Kramer & Hekking 3130* (U, VEN); río Saramacca, camino a Carl Francois, 2 jun 1944 (fl), *Maguire & Stahel 23596* (BR, U, US). **ECUADOR. Esmeraldas:** La Tola, 22 feb 1994 (fl), *Cornejo 1890* (GUAY, QCNE); N de Atacames, carretera Esmeraldas-Muisne, 31 jul 1980 (fl), *Hansen et al. 7931* (MO, USF); San José de Chamanga-Salina, 28 feb 1993 (fl), *Jaramillo 15203* (QCA). **BRASIL. Amapá:** NO de Amapá, 7 nov 1979 (fl), *Austin et al. 7339* (MG, US, WAG); Amapá, 3 jun 1944 (fl), *Baldwin 4096* (US). **Pará:** Ilha do Marajó, 12 nov 1948 (fl), *Black 3428* (IAN, MO); Marapánim, Camara, al NO de Marudá, 3–4 abr 1980 (fl), *Davidse et al. 17838* (US, WAG); Belém, 27 may 1947 (fl, fr), *Pires & Black 1619* (P, US). **Maranhão:** río Maracassumé, 9 sep 1932 (fl), *Froes 1886* (P, U); localidad perdida, 1856 (fl) *Gardner 6060* (BM, CGE, P, US, W [2 cartulinas]).

2. Rhabdadenia madida (Vell.) Miers, Apocyn. S. Amer. 121. 1878. (**Figs. 1, 2, 3A, 4B, 6C–D y 7**). *Echites madidus* Vell., Fl. Flum. 112. 1829. Tipo: BRASIL. Rio de Janeiro: Vell., Fl. Flumin., Icon 3: tab. 42. 1827 (lectotipo, designado aquí).

Rhabdadenia macrostoma (Benth.) Müll.Arg., Linnaea 30:435. 1860. *Rhabdadenia macrostoma* (Benth.) Müll.Arg. var. *glabrata* Müll.Arg., Linnaea 30:435. 1860. *Echites macrostomus* Benth., J. Bot (Hooker) 3:248. 1841. Tipo: GUYANA: localidad perdida, 1837 (fl, fr), *Schomburgk 329* (holotipo: K; isotipos: BM [fotografias, INB], CGE, G–DC [foto F neg. 7564], P [2 cartulinas, foto F neg 38759], P, US, W [2 cartulinas]).

Rhabdadenia macrostoma (Benth.) Müll.Arg. var. *pubescens* Müll.Arg., Linnaea 30:435. 1860. Tipo: SURINAM: Paramaribo, jun 1830 (fl), *Splitgerger s.n.* (holotipo: W).

Rhabdadenia pohlii Müll.Arg., Fl. Bras. 6(1):174, pl. 52. 1860. *Rhabdadenia pohlii* Müll.Arg. var. *volubilis* Müll.Arg., Fl. Bras. 6(1): 174. 1860. Tipo: BRASIL. Espiritu Santo: localidad exacta perdida, 1816–1821 (fl, fr), *St. Hilaire 328* (lectotipo, designado aquí, P [2 cartulinas]).

Rhabdadenia pohlii Müll.Arg. var. *suberecta* Müll.Arg., Fl. Bras. 6(1):175. 1860. *Rhabdadenia latifolia* (Müll.Arg.) Malme var *suberecta* (Müll. Arg.) Malme, Ark. Bot. 21A(6):18. 1927. Tipo: BRASIL. Minas Gerais: localidad perdida, 1816–1821 (fl), *St. Hilaire s.n.* (lectotipo, designado aquí, P [2 cartulinas]).

Rhabdadenia pohlii Müll.Arg. var. *latifolia* Müll.Arg., Fl. Bras. 6(1):175. 1860. *Rhabdadenia latifolia* (Müll.Arg.) Malme, Ark. Bot. 21A(6):17. 1927. Tipo: Brasil. Rio Grande do Sul: sin localidad precisa, 1835 (fl), *Isabelle 6* (holotipo: P).

Rhabdadenia mamorensis Rusby, Mem. New York Bot. Gard. 7:326. 1927. Tipo: BOLIVIA. Santa Cruz: cerca de Trinidad, 4 mar 1922 (fl), *Cárdenas 24* (holotipo: NY; isotipo: US).

Lianas, hierbas suberectas o erectas, tallos glabros, glabrescentes a esparcidamente puberulentos. Hojas con el pecíolo 2–5(–6) mm de largo, láminas (2.5–)3.2–8.2 × 0.6–2.7(–2.9) cm, angostamente ovadas, angostamente ovado-elípticas a elípticas, más raramente obovado-elípticas, el ápice obtuso-mucronado, redondeado-mucronado, agudo-mucronado o agudo, algunas veces muy cortamente apiculado, la base cordada, subcordada a redondeada o subtruncada, glabras, glabrescentes a densa a moderadamente puberulentas en ambas caras, las venas secundarias usualmente impresas, aunque a veces algo inconspicuas adaxialmente, venas terciarias no evidentes o levemente impresas abaxialmente. Inflorescencia con (1)2(3) flores, glabras o densa a moderadamente puberulentas, pedúnculo 2.5–8.7(–15.5) cm de largo, pedicelos 5–15 mm de largo, brácteas 3.5–6.5 × 0.7–1 mm, angostamente ovadas a linear-ovadas; sépalos (1.5–)2–10 × 0.6–2.2 mm, angostamente ovados, angostamente elípticos, linear-ovados a lineares, el ápice acuminado, foliáceos, glabros a puberulentos externamente; corola con los lóbulos púrpura, rosados a rosado intenso, raramente rojas (*Guareco 566*, INB), la parte inferior del tubo angostamente cilíndrica, (6–)8–12 × 1.1–2.1 mm, la parte superior cilíndrico-campanulada, 22–35 mm de largo, con un diámetro de 1–1.4 cm en la boca, el ápice del botón floral acuminado, lóbulos 1.5–2.5 × 1.2–2.1 cm, obovados; anteras (3.5–)5–7.5 mm de largo, glabras dorsalmente, excepto por la pubescencia apical, la base redondeada, cabeza estigmática 1.3–2 mm de largo; ovario 1.3–1.6 mm de largo, glabro, nectarios 1/2–2/3 de la longitud total del ovario, usualmente libres. Folículos 7.5–8.8 cm × 1–3.5 mm, glabros; semillas 2.1–2.4 cm de largo, glabras, la coma 1.7–3.9 cm de largo, blanca a blanco-crema.

Distribución, habitat y ecología.—Ampliamente difundida en casi toda Sur América (excepto Chile), donde crece en áreas inundadas, orillas de ríos, formaciones arbustivas en áreas arenosas, así como pantanos asociados a sabanas y bosques de Chaco asociado a zonas fangosas arenosas y bordes de esteros, en elevaciones de 0–500 m. La floración y fructificación ocurre durante todo el año.

Nombres comunes.—"huevo de gato" (Perú, Loreto, Bella Vista).

Esta especie se puede separar de *Rhabdadenia ragonesei* por sus flores con la parte inferior del tubo de la corola más pequeño, así como brácteas florales más pequeñas y hojas usualmente más anchas. *Rhabdadenia madida* es una especie polimórfica, tanto en lo referente al hábito y las hojas, como en el tamaño de los sépalos, lo cual ha sido comentado por varios autores (Ezcurra 1981; Ezcurra et al. 1992; Woodson 1936). De esta manera, esta especie puede ser una liana o comportarse como una hierba escandente o suberecta (Ezcurra 1981; Ezcurra et al. 1992; Woodson 1936). Aunque en forma general es más común el hábito de liana en todo el rango de distribución, los hábitos suberectos predominan en las poblaciones presentes en el S de Brasil, E de Bolivia, Paraguay, Uruguay y Argentina. En todo caso, en algunas poblaciones presentes en determinadas regiones de Paraguay se pueden encontrar ambos hábitos. Al estudiar en forma aislada cada

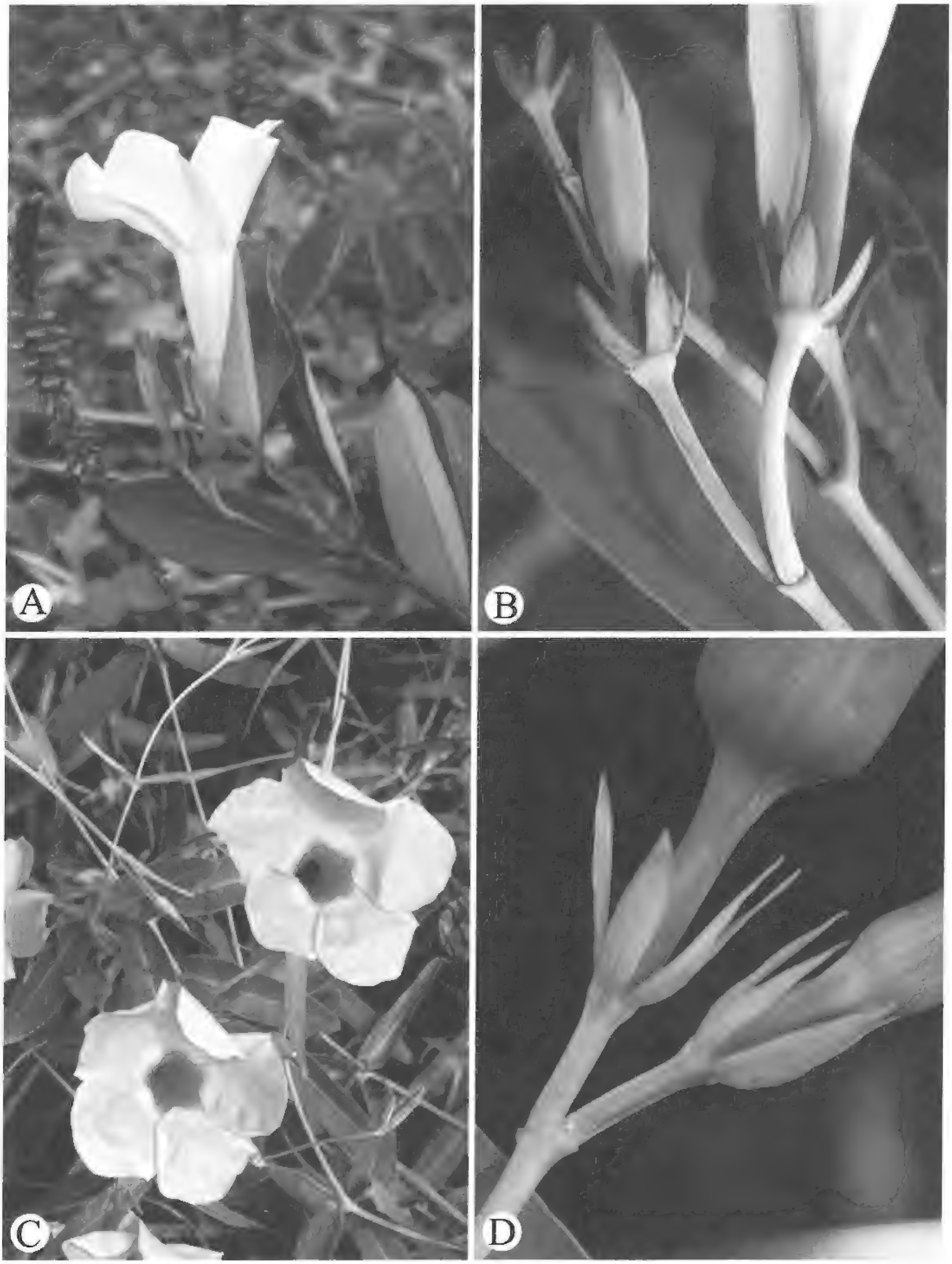


Fig. 6. Inflorescencias en *Rhabdadenia*. A–B. *R. biflora*. C–D. *R. madida*.

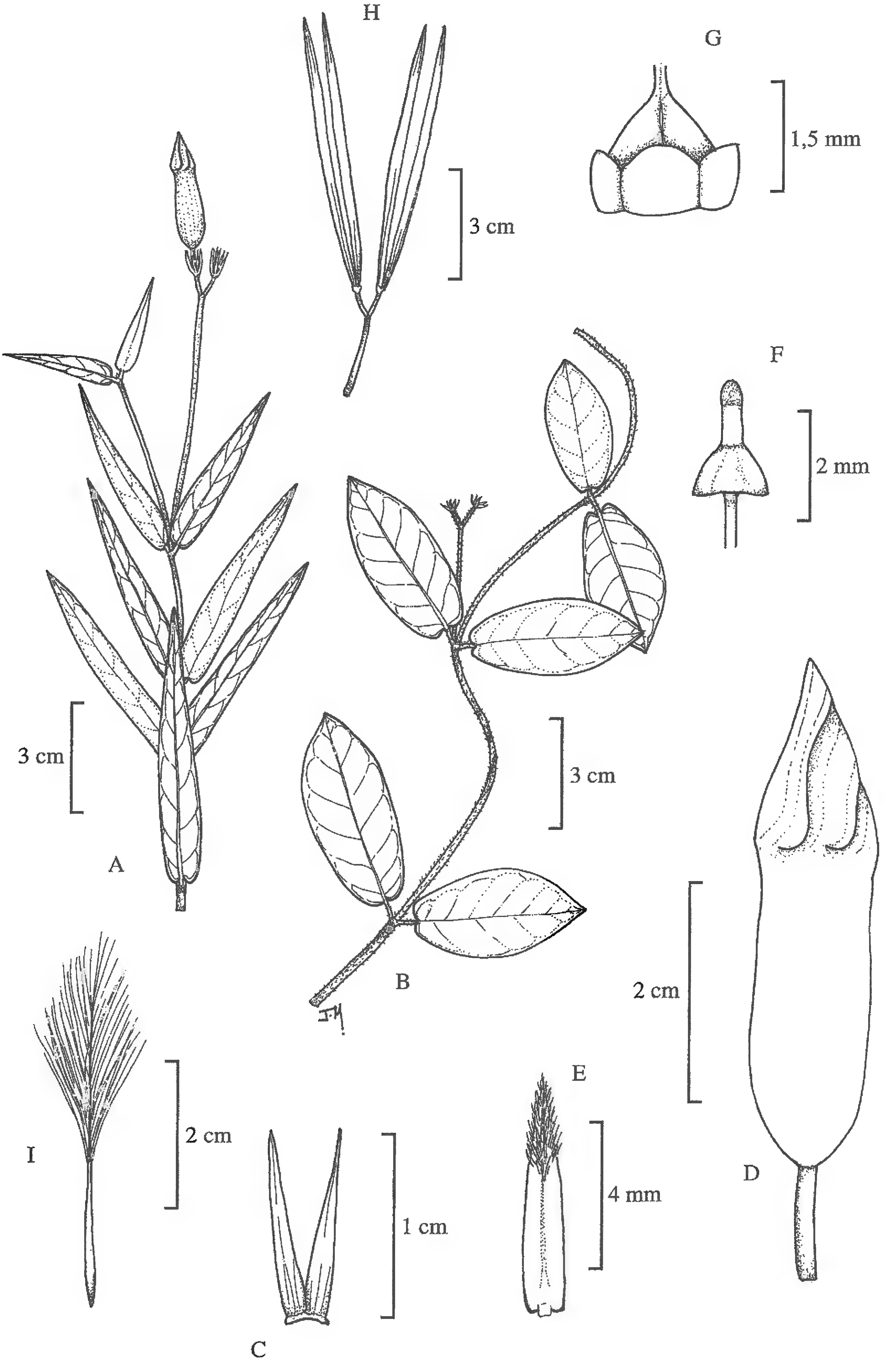

H
G
1,5 mm
3 cm
F
2 mm
3 cm
3 cm
A
B
J·M
2 cm
E
2 cm
I
4 mm
D
1 cm
C

Fig. 7. *Rhabdadenia madida* (A de *Zardini & Vera 47799*, INB; B–G de *Ritter 3763;* H–I de *Toledo & Chuvé 284*, INB). **A.** Ramita con inflorescencias. **B.** Ramita con inflorescencias. **C.** Vista de la cara adaxial de dos sépalos, mostrando la ausencia de coléteres en la base. **D.** Corola. **E.** Antera, vista dorsal. **F.** Cabeza estigmática. **G.** Nectarios y ovario. **H.** Folículos. **I.** Semilla.

una de estas variaciones sin un análisis morfológico exhaustivo en todo el rango de distribución geográfica, puede llevar a la conclusión errónea de reconocer diferentes taxones (a nivel de especie o varietal) (Müller, 1860), pero al examinar la gran cantidad de estados intermedios es claro que esto no es posible.

Otro carácter que tiene una alta variación dentro del género y en particular en esta especie se refiere a la longitud de los sépalos. Woodson (1936) separó *R. madida* de *R. pohlii* basado en el indumento de los tallos (esparcidamente pilosos vs. glabros) y en la longitud de los sépalos, de manera que en *R. madida* dio una longitud con un rango de 2–4 mm, mientras que en *R. pohlii* la variación que citó era de 8–12.5 mm. Es probable que estos rangos se cumplieran en los relativamente pocos especímenes examinados por él (6 especímenes de *R. madida* y 9 de *R. pohlii*), pero al analizar los mismos caracteres en el material disponible hoy en día, no son sostenibles ni excluyentes, ni siquiera a nivel de distribución geográfica. Esta situación había sido comentada previamente por Monachino (1958), quién cuestionó la utilidad de los caracteres utilizados por Woodson. Todavía más concluyente es la variación presente en los sépalos de una misma colección (e.g., *Smith & Klein 8305*), donde la longitud de los sépalos varía en un rango de 2–7(–9) × 0.5–1 mm. En todo caso, la misma variación en la longitud de los sépalos está presente en *R. biflora*, donde algunas poblaciones de las Antillas tienden a tenerlos más pequeños (en relación a las presentes en el Continente Americano). Por lo tanto, el mantener separada *R. madida* de *R. pohlii* basado en la longitud de los sépalos no es justificable. Situaciones similares se han presentado en géneros como *Odontadenia* (Apocynoideae, Apocyneae), donde diferentes taxones fueron separados basados en variaciones mínimas de ese carácter (Woodson 1935b), los que posteriormente han tenido que ser sinonimizados en monografías recientes (Morales 1999). Por otro lado, aunque a veces los tallos pueden ser esparcidamente puberulentos en algunos especímenes, este carácter varía de forma independiente en relación a la longitud de los sépalos y tampoco es consistente o excluyente para justificar la aceptación de *R. pohlii*.

En forma general es común encontrar especímenes de *Mandevilla angustifolia* (Malme) Woodson identificados como *Rhabdadenia madida*, ya que ambas especies comparten hojas con láminas foliares de similares formas y dimensiones y convergen en su distribución en algunas regiones geogfráficas, lo cual había sido anteriormente mencionado por Ezcurra et al. (1981, 1992). Sin embargo, a nivel vegetativo y sin entrar en un análisis detallado de las flores, los especímenes de *M. angustifolia* se pueden separar con facilidad por sus inflorescencias racemosas, usualmente con numerosas flores, así como por sus tallos viejos con los coléteres interpeciolares comúnmente desarrollados en tallos viejos y simulando pequeñas garras, lo cual no se presenta en *Rhabdadenia* (Ezcurra 1981, 1992). Otro carácter adicional también útil, se refiere a la presencia de coléteres en la base del nervio en la superficie adaxial de las hojas, lo cual es algo común en *Mandevilla*. Sin embargo, este tipo de coléteres son rápidamente caducos y a veces parecen estár ausentes en *M. angustifolia* (e.g., *Morales 9325*, INB), por lo que este carácter debe utilizarse en combinación con el resto de caracteres anteriormente mencionados.

En su monografía de *Rhabdadenia*, Woodson (1936) relegó el taxón *Echites madidus* Vell. a la sección de especies dudosas o excluidas y sugirió la posibilidad de que se tratara de una especie de *Mandevilla*. Sin embargo, basado en el análisis de la ilustración que acompaña la descripción original, donde se muestran inflorescencias reducidas a flores solitarias (algo que ocurre en *Rhabdadenia*), hojas con la base cordada (Fig. 1B), sépalos sin coléteres y el ovario con cinco nectarios relativamente diminutos y separados, se deduce que este epíteto específicorepresenta el nombre correcto a ser usado para *Rhabdadenia pohlii*, por tener fecha de publicación más antigua.

La colección *Saint Hilaire 328* es seleccionada como el lectotipo de *Rhabdadenia pohlii*, ya que es la colección mejor preservada y con mayor número de duplicados (2), mientras que el resto de los sintipos citado por Müller (*Gaudichaud 85*, *Pohl 5170*) son conocidos por una única colección, con la excepción de la colección realizada por Sello (s.n.) que no pudo ser localizada. En todo caso, es importante aclarar que existe una colección adicional (*St. Hilaire 527*) en el herbario de París (P) y anotada por Müller como *R. pohlii*, que también consta de dos duplicados, pero representa una planta suberecta (como se infiere fácilmente de la colección), por lo que dado su discrepancia con el protólogo original (donde se especifica que el taxón es "voluble"), no es escogida como el lectotipo.

De las colecciones citadas por Müller (1860 a) en la descripción de *Rhabdadenia pohlii* var. *suberecta* Müll. Arg., se selecciona a *Saint Hilaire s.n.* como el lectotipo. Esta colección está representada por dos duplicados, ambos en buen estado de conservación y que representan en forma clara los caracteres diagnósticos del protólogo. En todo caso, las restantes colecciones citadas por Müller (*Sello 799, Riedel 614, Langsdorff s.n.*), no fueron localizados.

Especímenes representativos examinados: **COLOMBIA. Amazonas:** Puerto Nariño, parque nacional natural Amacayacú, jul 2000 (fl), *Amaya & Melendez 173* (COL); cercanías de Leticia, 18 nov 1974 (fl, fr), *Gentry 12741* (MEXU, MO, US); Leticia, vía a Tarapacá, 28 oct 1991 (fl), *Pipoly et al. 15434* (MO, VEN); **Antioquia:** Caucasia, hacienda Quintero, 6 sep 2000 (fl), *Fonnegra et al. 7233* (HUA); Puerto Berrio, 14 jul 1917 (fl), *Pennell & Rusby 35* (NY). **Atlántico:** región de Manatí, 29 mar 1935 (fl), *Dugand 743* (F); Barranquilla, ago 1927 (fl), *Elias 295* (US). **Bolivar:** río Mara, ene 1918 (fl), *Pennell 3956* (MO, NY, US); Mompós, Rinconada, dic 1982 (fl, fr), *Ramírez 4* (COL); Palotal, Ayapel, 12 may 1949 (fl, fr), *Romero-Castañeda 1635* (COL, MO). **Chocó:** Riosucio, río Truandó, entre Riosucio y Calle Larga, 21 ago 1986 (fl), *Espina & Mosquera 2097* (COL, CHOCO); río Atrato, cerca de río Sucio, 16 ene 1974 (fl), *Gentry 9243* (MO [2 cartulinas], Z); río Cacarica, 1 jul 1957 (fl), *Romero-Castañeda 6336* (COL, MO, NY, P). **Córdoba:** ciénaga de Ayapel, 10 jul 1973 (fl), *Idrobo & Cleef 6572* (COL, U, WAG); Ayapel, ciénaga de Ayapel, 6 dic 1989 (fl, fr), *Marulanda 1626a* (HUA). **Magdalena:** Barro Blanco, 30 nov 1945 (fl), *Haught 4752* (US). **Meta:** cercanías Villavicencio, hacienda Mozambique, 7 mar 1971 (fl), *Sastre & Pinto 1020* (COL, MO, P); parque nacional natural Tinigua, Serranía Chamusa, ene 1995 (fl), *Stevenson 1357* (COAH, NY). **VENEZUELA. Apure:** entre río Orinoco y Piedra La Villa, 27 ene 1956 (fl), *Wurdack & Monachino 41391* (MO, NY, P, U, US, W, VEN). **Amazonas:** Orinoco, Sacupana, abr 1886 (fl), *Rusby & Squires 20* (MO, NY, US, W, WU). **Bolivar:** carona, Matanzas, antes de Puerto Ordaz, 15 may 2001 (fl), *Díaz & Aguilera 5172* (VEN); entre San Félix y Puerto Ordaz, jun 1964 (fl), *Steyermark 94620* (NY, US, VEN). **Cojedes:** San Carlos de Cojedes, 9 may 1946 (fl), *Velez 2735* (US, VEN). **Delta Amacuro:** Caño Cocoina, 23 jun 1993 (fl), *Colonnello 1358* (MO); Tucupita, entre Tucupita y Las Mulas, 13 oct 1977 (fl), *Steyermark et al. 114584* (MO, NY, VEN); Tucupita, Caño Jota-Sabuca, entre Laguna del Consejo y Caño Mariusa, 24 oct 1977 (fl), *Steyermark et al. 115321* (MO, VEN). **Guarico:** Miranda, parque nacional Aguaro-Guariquito, SE de la montaña de Guardahumo, dic 1981 (fl), *Delascio et al. 11374* (VEN); SO de Calabozo, Hato Masaguaral, 1 sep 1983 (fl), *Rondeau 456* (ARIZ, MO, VEN). **Mérida:** entre Santa Bárbara y Encontrados, 12 feb 1953 (fl), *Bernardi 362* (NY). **Monagas:** La Pica, cerca de Maturín, jul 1959 (fl), *Aristeguieta 3929* (NY, VEN); río Guarapiche, al SSO de Jusepín, 22 feb 1967 (fl), *Pursell 8131* (VEN). **Táchira:** Caño La Ceiba, NE de Orope, 15 nov 1979 (fl), *Steyermark et al. 120423* (MO, VEN). **Trujillo:** El Cenízo, 28 abr 1951 (fl), *Lasser 2833* (VEN); la Ceiba, 3 dic 1922 (fl), *Pittier 10887* (NY, US, VEN). **Zulia:** S de río Catatumbo, 27 mar 1982 (fl), *Liesner & González 13264* (MO, WAG, VEN); Perijá, s.d. (fl), *Tejera 209* (US). **GUYANA:** Entre Berbica y Rupununi, 20 jun 1919 (fl), *Abraham 209* (NY); Mulson creek, Berbice, 10 feb 1977 (fl), *Grewal 267* (U). **SURINAM:** río Coppename, 23 dic 1948 (fl), *Lanjouw & Lindeman 1555* (NY, U); Nickerie, entre Hampton Court y Henar-polder, 8 may 1949 (fl), *Lanjouw & Lindeman 3178* (NY, U); Paramaribo, 1851 (fr), *Wullschlägel 326* (BR, NY, W [2 cartulinas]). **GUYANA FRANCESA.** Alrededores de Kourou, jun 1969 (fl), *Petitbon 121* (P); río de Kaw, 5 sep 1979 (fl), *Prévost 747* (P). **ECUADOR. Sucumbios:** NO de Añangu, cerca del río Napo, 8 jun 1995 (fl), *Clark et al. 1070* (MO, US). **PERÚ. Amazonas:** Caballocochа, 14 ago 1989 (fl, fr), *Vásques & Jaramillo 12716* (MO). **Loreto:** Iquitos, ago 1929 (fl), *Killip & Smith 26911* (MO, NY, US); Maynas, río Ampiyacu, Pebas, 27 abr 1977 (fl), *Plowman et al. 7066* (MO, US, USM, Z); Quebrada de Maquia, Contamina, 16 dic 1964 (fl), *Schunke 6676* (MO, UC, US, USM). **Madre de Dios:** Laguna Coco Cocha, 3 jun 1986 (fl), *Funk et al. 8410* (P); Tambopata, cerca de la unión de los ríos Tambopata y La Torre, 26 jul 1985 (fl), *Gentry et al. 51387* (MO [2 cartulinas]); SO de Puerto Maldonado, cerca de la confluencia de río Tambopata y río La Torre, 16 oct 1985 (fl), *Smith et al. 776* (MO, NY, US). **Ucayali:** Coronel Portillo, Lago Yarinacocha, Cashivo cocha, 25 nov 1997 (fl, fr), *Graham & Vigo 381* (MO, NY). **BRASIL. Amapá:** Rio Jari, Santo Antonio da Cachoeira, 30 jul 1961 (fr), *Egler & Irwin 46056* (NY, U, US, VEN); Ariramba, 23 jun 1982 (fl), *Rosa & Alfeu 4395* (MG, NY). **Amazonas:** Lago de Janauacá, S de Río Solimões, Varzea, 28 ago 1973 (fl, fr), *Berg et al. 19785* (INPA, MO, NY, U, US); Igarapé Belém, 24 dic 1948 (fl, fr), *Fróes 23781a* (IAN, MO); Río Solimões, cerca de Codajaz, 19 may 1933 (fl), *Krukoff 4500* (MO, NY, U, US). **Brasília:** Recreio dos bandeirantes, 29 oct 1938 (fl), *Pulle & Lutz s.n.* (R, U). **Mato Grosso:** Cáceres, cerca de río Paraguai, 8 nov 1996 (fl), *Hatschbach et al. 65385* (MBM, WAG); Río Alegre, Vila Bela da Santissima Trinidade, barra do río Guaporé, 17 nov 1996 (fl), *Hastchbach et al. 65647* (INB, MBM, U, WAG); Poconé, Pantanal, camino a Porto Jofre, 25 oct 1985 (fl, fr), *Thomas et al. 4563* (NY). **Minas Gerais:** Canandaí, 22 dic 1949 (fl), *Duarte 2284* (MO, RB); João Agres, 31 dic 1866 (fl), *Glaziou 16248* (P); Oliveira, 5 abr 1997 (fl), *Neto 2602* (BHCB, INB). **Pará:** Oriximiná, Río Trombetas, lago Iripixi, 12 sep 1980 (fl), *Cid et al. 2406* (INPA, MO, NY, US, WAG); Ihla do Marajó, río Mocões, Anajás, 28 oct 1984 (fl, fr), *Sobel et al. 4839* (MO, NY, US); Rio Maicurú, 31 jul 1981 (fr), *Strudwick et al. 3936* (MO, NY, US, USF). **Paraná:** São José dos Pinhaes, Rincão, 22 ene 1950 (fl), *Hatschbach 1792* (MBM, US); Contenda, camino do Xisto, 31 dic 1967 (fl), *Hatschabch 18229* (MBM, NY, P, US); Guarapuava, 14 dic 1965 (fl), *Reitz & Klein 17622* (P, US, WAG). **Rio Grande do Sul:** Corumbá, 7 nov 1980 (fl), *Mizoguchi 2420* (MO); Bom Jesús, 5 ene 1947 (fl), *Rambo 34990* (MO, SI). **Rio de Janeiro:** Mage, Piedade, 14 dic 1869 (fl), *Glaziou 4082* (P); entre Campos y Morro do Coco, 8 dic 1964 (fl), *Trinta & Fromm 1029-2105* (HB, NY); Recreo de Bandeirantes, ene 1935 (fl, fr), *Lutz s.n.* (R, US). **Santa Catarina:** campo do Massiambú, Palhoça, 19 dic 1953 (fl), *Reitz 4949* (NY); Curitibanos y Campos Novos, 5 dic 1956 (fl), *Smith & Klein 8305* (MO, NY, US); Chapecó, Fazenda Campo São Vicente, 26–28 dic 1956 (fl), *Smith & Klein 11588* (US). **São Paulo:** Parajussará, 29 dic 1920 (fl), *Gehrt 4741* (NY); Moji-Guaçu, NNO de Padua Sales, sep 1960 (fl), *Mattos & Mattosu 8243* (US); Bairro Caete, São Roque, al O de São Paulo, 2 dic 1987 (fl), *Tsugaru & Otsuka 2263* (MO, NY). **BOLIVIA. Beni:** Marban, San Rafael, Curiche, 6 oct 1979 (fl), *Beck 2665* (LPB, MO, P, SI, WAG); Ballivián, río Yacuma, 21 oct 1980 (fl), *Beck 5257* (LPB, MO, SI), Moxos, O de Trinidad, 21 oct 1984 (fl), *Greg & Schmitt 151* (LPB, MO, NY, U, USF). **Cochabamba:** Carrasco, Valle de Sajta, 20 mar 1995 (fl), *Ritter 1688* (MO). **La Paz:** Iturralde, Luisita, al O del río Beni, 11 sep 1984 (fl, fr), *Haase 533* (LPB). **Santa Cruz:** Nuflo de Chavez, Estancia San Miguelito, 24–26 jul 1995 (fl), *Fuentes 996* (LPB, USZ); Velasco, El Refugio, 3 may 1995 (fl), *Guillén & Choré 3484* (INB, MO); Guarayos, río Negro, 12 jun 1990 (fr), *Vargas 595* (LPB, NY, USZ). **PARAGUAY. Alto Paraguay:** frente a Valle Mi, Riacho Mosquito, 17 oct 2000 (fl), *Kiesling et al. 9696* (SI); Olimpo, nov 1991 (fl), *Schmeda 1449* (US); Cucarani, dic 1951 (fl), *Schmeda 1590* (US). **Alto Paraná:** río Alto Paraná, 1909 (fl), *Fiebrig 6451* (G, SI); Estancia río Bonito, 28 feb 1996 (fl), *Zardini et al. 44707* (AS, MO). **Amambay:** entre río Apa y río Aquidabán, Estrella, dic sin año (fl), *Hassler 7816* (BM, G, NY). **Caaguazú:** praderas marécagenses, 16 nov 1874 (fl), *Balansa 1355* (G, P). **Caazapá:** Tavai, propiedad Bogado, 20 dic 1988 (fl), *Mereles 2146* (FCQ, G, INB, SI); Tavai, Arroyomboi Shini, 3 dic 1966 (fl), *Ortiz 855* (FCQ, MO); Estancia Tapytá, 13 dic 1999 (fl), *Zardini & Britez 52758* (INB, MO). **Canendiyú:** cerca de Curuguaty, Arroyo Schiní, 3 feb 1982 (fl, fr), *Fernández-Casas & Molero 5874* (G, MA, MO, NY); Sierra de Maracayú, río Jejui guazú, 1904 (fl), *Hassler 5731* (BM, G, NY, P, W); reserva natural Mbaracayú, 14 ene 1998 (fl), *Zardini & Vera 47799* (INB, MO). **Central:** Luque, Tarumandy, ago 1991 (fl), *Mereles 4062* (FCQ, MO). **Concepción:** Sargento José E. López, 16 ene 2000 (fl), *Zardini & Guerrero 53938* (INB, MO). **Cordillera:** Tucanguá, feb 1898–1899 (fl), *Hassler 3841* (G, NY, P). Itapua: reserva Yacyreta, 5 dic 2002 (fl), *Zardini & Gamarra 59320* (INB, MO). **Gran Chaco:** Loma Clavel, 1903 (fl), *Hassler 2470* (BM, G, NY, P, W). **Misiones:** Ayolas, 4 dic 2000 (fl), *Zardini & Guerrero 55892* (INB, MO). **Neembucú:** río Paraguay, sin fecha (fl), *Page s.n.* (US). **Presidente Hayes:** carretera Fortín Martínez, 11 nov 1985 (fl), *Brunner 1358* (G, MO, PY, SI); Puerto Militar, río Paraguay, Casuariaga, 9 dic 1989 (fl), *Vanni et al. 1226* (CTES, MO); Pozo Colorado-Monte Lindo, 30 jul 1997 (fl), *Zardini & Guerrero 47263* (INB, MO). **San Pedro:** Lima, estancia Carumbé, 6 oct 1967 (fl), *Pedersen 8516* (C, P); entre Santa Rosa y Santa Bárbara, 29 oct 1996 (fl), *Zardini & Guerrero 45517* (INB, MO); Antequera, 23 jun 2001 (fl), *Zardini & Guerrero 56633* (INB, MO). **URUGUAY. Colonia:** río de la Plata, 1853–1856 (fl), *Page s.n.* (US). **ARGENTINA. Corrientes:** Santo Tomé, Chimiray, 12 nov 1974 (fl), *Schinini & Carnevali 10299* (CTES, MO); Paso Crucecita, 6 ene 1960 (fl), *Pedersen 5328* (C, P, US). **Formosa:** Pilagá, camino a Puerto San Ramón, 18 nov 1991 (fl), *Fortunato et al. 2429* (BAB, MO, SI). **Misiones:** Concepción, 28 ene 1926 (fl, fr), *Clos 1979* (BAB); San Ignacio, ene 198 (fl), *Hauman 3591* (MO).

3. Rhabdadenia ragonesei Woodson, Lilloa 5:19. 1940. (**Fig. 8**). TIPO: ARGENTINA. SANTA FE: General Obligado, entre Villa Guillermina y Rabón, 14 feb 1938 (fl), *Ragonese 3627* (HOLOTIPO: MO; ISOTIPOS: LIL, MO).

Lianas, tallos glabros. Hojas con el pecíolo 1.5–5.5(–8) mm de largo, láminas 7.1–10.9 cm × 1.8–7.5(–12.5) mm, lineares a linear-elípticas, el ápice acuminado, la base angostamente cuneada, angostamente obtusa a angostamente subcordada, glabras, venas secundarias inconspicuas o no evidentes, venas terciarias no evidentes. Inflorescencias glabras con 1–2(3) flores, pedúnculo 4.1–9.2 cm de largo, pedicelos 4–10(–12) mm de largo, brácteas 8–11 × 0.4–0.7 mm, lineares; sépalos 11–15 × 1–1.3 mm, lineares a linear-ovados, el ápice acuminado, subfoliáceos, glabros externamente; corola rosada, la parte inferior del tubo 31–34 × 1.1–1.9 mm, la parte superior obcónica, 26–31 mm, con un diámetro de 1.3–1.6 cm en la boca, el ápice del botón floral acuminado, lóbulos 2.8–3.5 × 2.4–2.8 cm obovados; anteras 4.5–5 mm de largo, glabras dorsalmente, excepto por la pubescencia apical, la base inconspicuamente auriculada, con las aurículas agudas; cabeza estigmática 1.8–2 mm de largo; ovario 1–1.3 mm de largo, glabro, nectarios ca. la mitad de la longitud del ovario, usualmente libres. Folículos 7.1–8.8 cm × 1–1.5 mm, glabros; semillas 2.2–2.7 cm de largo, glabras, la coma 1.5–3.4 cm de largo, blanca a blanco-crema.

Distribución, habitat y ecología.—Restringida al S de Brasil (Estado de Mato Grosso do Sul), Paraguay, y el N de Argentina, donde crece en pantanos, bancos de ríos y sabanas inundadas, en elevaciones bajo los 500 m. Especímenes con flores han sido recolectados entre noviembre y marzo. Frutos se han recolectado en enero y febrero.

Rhabdadenia ragonesei puede confundirse fácilmente con la polimórfica *R. madida*, pero se puede separar con facilidad por sus flores con la parte inferior del tubo de la corola más largo, de 31–34 mm de longitud (vs. (6–)8–12 mm), así como por sus hojas usualmente más angostas. Otro carácter útil para reconocer esta especie se refiere a la longitud de las brácteas florales, ya que aunque todos los taxones del género tienen brácteas angostas y escariosas, *R. ragonesei* tiene las brácteas más largas, con un rango de 8–11 mm de largo (vs. 1–6.5 mm). Aunque se puede pensar que este taxón representa tan solo una variación de *R. madida*, hasta el momento no se encuentran especímenes que reflejen un estado intermedio de los caracteres diagnósticos utilizados para separalas.

Existe una colección de Argentina de la provincia de San Juan (*Kermes s.n.*, BAB), una región relativamente austral para el ámbito de distribución geográfica conocida de este taxón, donde hasta el momento no había sido reportada esta especie (Ezcurra 1981; Woodson 1936). Ese espécimen puede representar una colección con una localidad o etiqueta errónea.

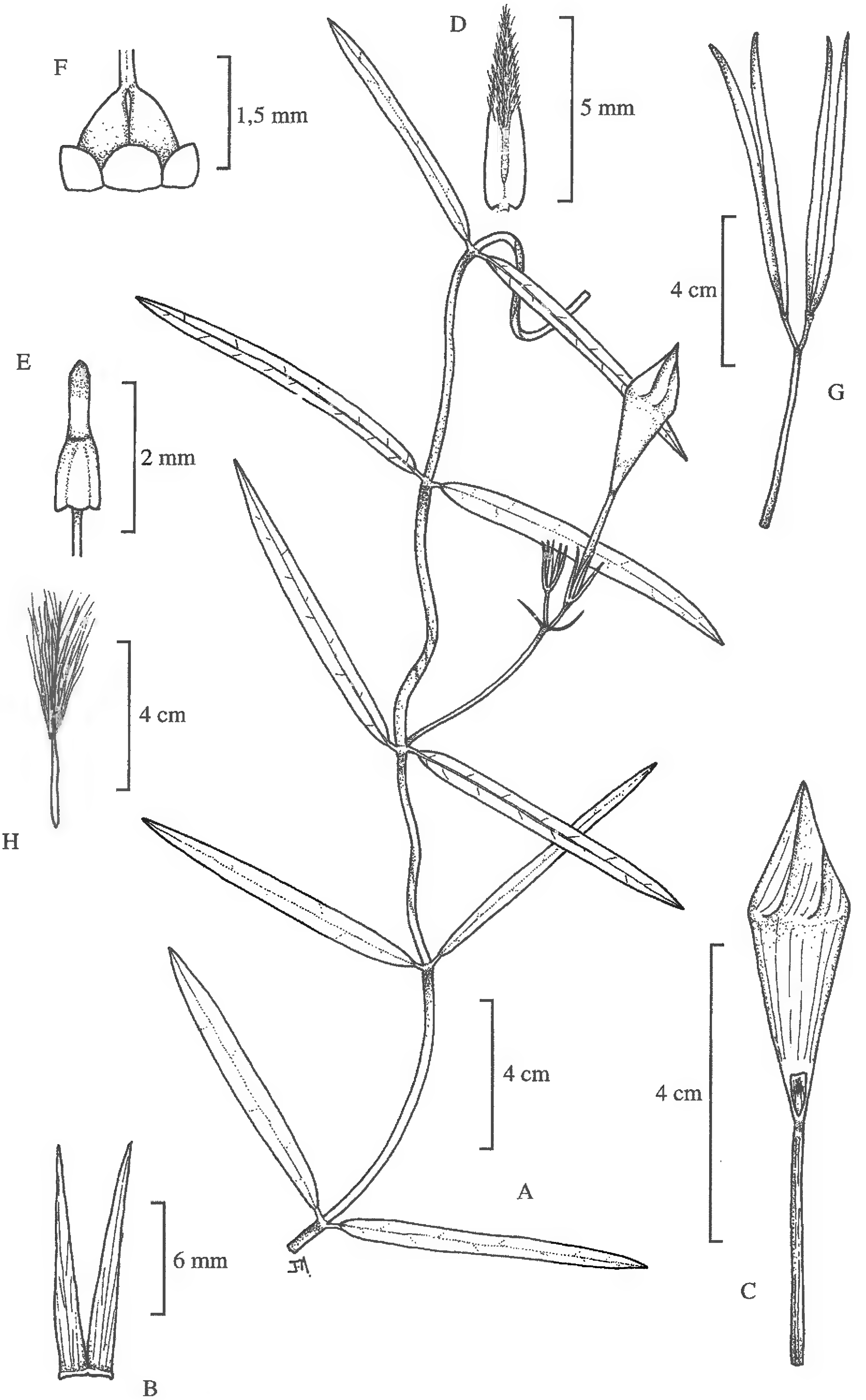


Fig. 8. *Rhabdadenia ragonesei* (A–G de *Guaglianone et al. 408*, INB; H–I de *Zardini & Tilleria 37786*, INB). **A.** Ramita con inflorescencia. **B.** Vista de la cara adaxial de dos sépalos, mostrando la ausencia de coléteres en la base. **C.** Corola parcialmente abierta, mostrando la posición de las anteras. **D.** Antera, vista dorsal. **E.** Cabeza estigmática. **F.** Cabeza estigmática. **G.** Nectarios y ovario. **H.** Folículos. **I.** Semilla.

Especímenes representativos examinados: **BRASIL. Mato Grosso do Sul:** Bataguaçu, río Parana, 21 nov 1992 (fl), *Cordeiro et al. 1028* (MO, SP). **PARAGUAY. Caaguazú:** Arroyo Yakare'i, 8 feb 1989 (fl), *Zardini & Velásquez 10815* (FCQ, MO). **Chaco:** Puerto Casado, dic 1916 (fl), *Rojas 2095* (SI). **Central:** Estero del Ypoá, al SO de Nueva Italia, Isla Guazú, 10 feb 1990 (fl), *Zardini & Velásquez 18744* (SI). **Cordillera:** río Piribebuy, al W de Arroyos y Esteros, 23 dic 1989 (fl), *Zardini & Velásquez 17209* (SI). **Guairá:** Itapé, ene 1901 (fl), *Jörgensen 4038* (NY, SI, US). **Itapua:** Isla Yacyreta, 21 ene 1997 (fl, fr), *Zardini & Villate 46237* (AS, MO), 23 oct 1999 (fl), *Zardini & Gamarra 51849* (INB, MO). **Misiones:** río Atinguy, entre Ayolas y San Cosme y Damián, 22 ene 1997 (fl), *Zardini & Guerrero 46399* (INB, MO). **Paraguari:** Lago Ypoá, al E de Cerro Taruma, 4 ene 1994 (fl, fr), *Zardini & Tilleria 37786* (INB, MO). **Presidente Hayes:** Pozo Colorado, 2 nov 2001 (fl), *Zardini & Vera 57163* (INB, MO). **San Pedro:** Sierra de Maracayú, río Tapiraguay, 1904 (fl), *Hassler 4174* (NY,P, W); Alto Paraguay, Primavera, Tapiraguay, 22 mar 1955 (fl), *Woolston 483* (K, MO, SI, U). **ARGENTINA. Chaco:** Colonia Benitez, 1931 (fl), *Schulz 238* (SI); Primero de Mayo, Colonia Benítez, dic 1952 (fl), *Schulz 8388* (BAB, CTES, LPB, SI). **Corrientes:** San Roque, estancia San Antonio, camino a Concepción, 4 dic 1996 (fl), *Arbo et al. 7010* (CTES, CUVC, LPB, MEXU); Mercedes, macrosistema Ibera, estancia Rincón del Diablo, laguna Yacaré, 30 nov 1998 (fl), *Arbo et al. 8050* (CTES, CUVC, HUEFS); Mburucuyá, Estancia Santa Teresa, 9 feb 1951 (st), *Pedersen 1004* (BR, C, MO, NY, P, U, US). **Formosa:** parque nacional Pilcomayo, Puerto de Gendarmería La Angela, 18 mar 1992 (fl), *Fortunato 2811* (MO); Pilcomayo, N de Riacho He He, 6 ene 1980 (fl), *Guaglianone et al. 408* (INB, MO, SI). **San Juan**: Ubivurá, Bermejo, 29 ene 1907 (fl), *Kermes s.n.* (BAB).

ESPECIES EXCLUIDAS O DUDOSAS

Echites lucidus Willd. ex Roem. & Schult., Syst. Veg. 4:795. 1819. *Rhabdadenia lucida* (Willd. ex Roem. & Schult.) Miers, Apocyn. S. Amer.: 123. 1878. Tipo: VENEZUELA. Amazonas: río Orinoco, sin fecha (fl), *von Humboldt & Bonpland s.n.* (holotipo: P-HB) = *Odontadenia nitida* (Vahl) Müll.Arg.

Echites barbatus Desv. ex Ham., Prodr. Pl. Ind. Occid. 30–31. 1825. *Rhabdadenia barbata* (Desv. ex Ham.) Miers, Apocan. S. Amer. 123. 1878. Tipo: Antillas, sin datos (fl), *Hamilton s.n. en herb. Desvaux* (holotipo: P) = *Pentalinon luteum* (L.) B.F. Hansen & Wunderlin.

Echites campestris Vell., Fl. Flumin. 113. 1829. *Amblyanthera campestris* (Vell.) Müll.Arg., Fl. Bras. 6(1):149. 1860. *Rhabdadenia campestris* (Vell.) Miers, Apocyn. S. Amer.: 121. 1878. Tipo: BRASIL. Rio de Janeiro: Vell., Fl. Flumin., Icon 3: tab. 43. 1827 (lectotipo, designado por Morales [2007]) = *Mandevilla hirsuta* (Rich) K. Schum.

Echites berterii A. DC., Prodr. 8:447. 1844. *Rhabdadenia berterii* (A. DC.) Müll.Arg., Linnaea 30:435. 1860. *Angadenia berterii* (A. DC.) Miers, Apocyn. S. Amer.: 180. 1878. Tipo: REPÚBLICA DOMINICANA: Santo Domingo, 1821 (fl), *Bertero s.n.* (holotipo: G-DC [foto F neg 33879]) = *Angadenia berterii* (A. DC.) Miers.

Echites sagraei A. DC., Prodr. 8:450. 1844. *Rhabdadenia sagraei* (A. DC.) Müll.Arg., Fl. Brit. W. I. 415. *Angadenia sagraei* (A. DC.) Miers, Apocyn. S. Amer.: 181. 1878. Tipo: CUBA: datos perdidos, 1899 (fl), *Ramón. de la Sagra 81* (holotipo: G-DC [foto F neg 33881]; isotipo: P) = *Angadenia berterii* (A. DC.) Miers.

Rhabdadenia cubensis Müll.Arg., Linnaea 30:435. 1860. *Angadenia havanensis* Miers, Apocyn. S. Amer.: 181. 1878, nom. illeg. Tipo: CUBA. Holguin: Sabanas de Saltadero, may 1844 (fl), *Linden 1716* (holotipo: G-DC; isotipos: BR, P) = *Angadenia berterii* (A. DC.) Miers.

Rhabdadenia lindeniana Müll.Arg., Linnaea 30:437. 1860. *Angadenia lindeniana* (Müll.Arg.) Miers, Apocyn. S. Amer.: 180. 1878. Tipo: CUBA. Santiago de Cuba: cerro Líbano, may 1844 (fl) *Linden 1823* (lectotipo, designado aquí, BR; isolectotipos, G-DC, P) = *Angadenia lindeniana* (Müll.Arg.) Miers.

De los dos sintipos citados por Müller (1860 b) se designa la colección Linden 1823 depositada en el herbario de Bruselas (BR), Bélgica, como el lectotipo, dado que esta colección posee más duplicados y está en mejor estado de conservación que el otro sintipo (Linden 1700, P [3 cartulinas]).

Rhabdadenia lindeniana Müll.Arg. var. *angustifolia* Müll.Arg., Linnaea 30:437. 1860. Tipo: CUBA: datos de localidad perdidos, 1843–1844 (fl), *Linden 1699* (holotipo: W; isotipos: BM, G, NY [fragmento], MO) = *Angadenia lindeniana* (Müll.Arg.) Miers.

Rhabdadenia wrightiana Müll.Arg., Linnaea 30:438. 1860. *Mandevilla wrightiana* (Müll.Arg.) Benth., Gen. Pl. 2:727. 1876. Tipo: Cuba. Oriente: entre Paso Estancia y Pinales, may 1860 (fl), *Wright 399* (holotipo: G; isotipos: B [destruido], GH, MA, MO [2 cartulinas], NY, P, US, W [2 cartulinas]) = *Neobracea valenzuelana* (A. Rich.) Urban.

Rhabdadenia laxiflora Miers, Apocan. S. Amer. 120. 1878. Tipo: CUBA: sin localidad ni fecha (fl), *Wright 400* (holotipo: BM; isotipos: G, K [3 cartulinas]) = *Pentalinon luteum* (L.) B.F. Hansen & Wunderlin.

Rhabdadenia corallicola Small, Bull. New York Bot. Gard. 3:434. 1905. Tipo: ESTADOS UNIDOS. Florida: entre Cocoanut Grove y Cutler, 31 oct–4 nov 1903 (fl, fr), *Small & Carter 714* (holotipo: NY; isotipo: NY) = *Angadenia berterii* (A. DC.) Miers.

Rhabdadenia polyneura Urb., Symb. Antill. 7:337. 1912. *Odontadenia polyneura* (Urb.) Woodson, Ann. Missouri Bot. Garden 18:546. 1931. Tipo: REPÚBLICA DOMINICANA: Santo Domingo: entre Constanza y Río Jimenoa, Loma del Hato quemado, 1400 m, jun 1910 (fl), *von Tuerkheim 3341* (holotipo: NY [fotografía, INB]; isotipos: BR, G, GH, M, U, US, W, WU, Z) = *Odontadenia polyneura* (Urb.) Woodson.

APÉNDICE 1

ÍNDICE A NOMBRES EN EL TRATAMIENTO SISTEMÁTICO

Apocynum
cordatum Mill. (= R. biflora)
nervosum Mill. (= R. biflora)
Dipladenia
billbergii Beurl. (= R. biflora)
Echites
biflorus Jacq. (= R. biflora)
ehrenbergii Schltdl. (= R. biflora)
macrostomus Benth. (= R. madida)
paludosus Vahl (= R. biflora)
Exothostemon
paludosum (Vahl) G. Don (= R. biflora)
Rhabdadenia
biflora (Jacq.) Müll.Arg.
cordata (Mill.) Miers (= R. biflora)
ehrenbergii (Schltdl.) Müll.Arg. ex Griseb. (= R. biflora)
latifolia (Müll.Arg.) Malme (= R. madida)
macrantha Donn. Sm. (= R. biflora)
macrostoma (Benth.) Müll.Arg. (= R. madida)
macrostoma (Benth.) Müll.Arg. var. *glabrata* Müll.Arg. (= R. madida)
madida (Vell.) Miers
mamorensis Rusby (= R. madida)
nervosa (Mill.) Miers (= R. biflora)
paludosa (Vahl) Miers (= R. biflora)
pohlii Müll.Arg. (= R. madida)
pohlii Müll.Arg. var. *latifolia* Müll.Arg. (= R. madida)
pohlii Müll.Arg. var. *suberecta* Müll.Arg. (= R. madida)
pohlii Müll.Arg. var. *volubilis* Müll.Arg. (= R. madida)
ragonesei Woodson

APÉNDICE 2

ÍNDICE A LOS EJEMPLARES ESTUDIADOS

Rhabdadenia biflora (Jacq.) Müll.Arg.
Rhabdadenia madida (Vell.) Miers
Rhabdadenia ragonesei Woodson

Abbott 1444 (1), 2417 (1), 2847 (1); Abraham 209 (2); Acevedo-Rodríguez 414 (1), 415 (1), 6535 (1); Acosta 2202 (1); Afanador s.n. (1), s.n. (1); Agostini 2720 (1); Aguilar 5679 (1), 6205 (1); Alain 2535 (1); Allen 885 (1), 6633 (1); Allorge 1023 (1); Almeda 285 (1); Amaya 173 (2); Arbo 6022 (3), 6582 (3), 7010 (3), 8050 (3); Arenas s.n. (2); Ariste-Joseph 954 (1); Aristeguieta 2044 (1), 3929 (2), 4773 (1); Arvigo 365 (1); Asplund 4964 (1); Atha 948 (1); Atwood 4393 (1); Austin 7339 (1); Ayala 5571 (2).

Baker 412 (1); Balansa 1355 (1); Balcazar 125 (2); Baldwin 4096 (1); Bamps 5107 (1); Benoist 451 (1); Berg 19785 (2); Bernardi 362 (2); Betancur 1983 (1), 2006 (1), 8061 (1); Beck 2665 (2), 5161 (2), 5257 (2), 5361 (2), 5914 (2), 6575 (2), 16671 (2), 27985 (2); Beetle 26219 (1); Bena s.n. (1), 2427 (1); Bernal 133 (1); Berti 699 (1); Billiet 4296 (1), 4734 (1), 5136 (1); Black 2220 (2), 3428 (1); Boelcke 5288 (3); Boldo s.n. (1); Bonpland 1354 (1); Boom 8028 (1); Bordenave 102 (1); Borrero s.n. (1); Box 576 (1); Brito 43 (2); Britton 582 (1), 23070 (1); Broadway 365 (1), 428 (1); Bruijn De 1301 (1); Brumbach 9072 (1); Brunner 1358 (2); Bunting 1278 (1); Burchell 10057 (1); Burger 12298 (1); Burkart 30041 (3), 31025 (3); Byron, 158 (2).

Cabrera 117 (1), 4013 (1), 6762 (1); Callejas 5030 (1); Cano 793 (3); Cárdenas 24 (2), 6191 (2); Cardona 593 (1); Carrión 745 (2); Castillo 2720 (1); Castro 99 (2); Cavalcante 1810 (2); Cedillo 3371 (1); Chapman s.n. (1), 165 (1); Chavarría 223 (1); Chessman 389 (1); Cid 1021 (2), 2406 (2); Clark 1070 (2); Clemente 6201 (1); Clos 1979 (2); Colonello s.n. (1), 1358 (2), 1375 (2), 1502 (2), 2005 (2); Combs 78 (1); Contreras 9471 (1); Cordeiro 1028 (3); Core 1570 (1); Cornejo 1890 (1); Correll 41941 (1); Craighead s.n. (1); Cremmers 9523 (1); Croat 248 (1), 267 (1), 6574 (1), 8296 (1), 9994 (1), 11067 (1), 36871 (1), 36895 (1), 76261 (1); Cruz 945 (1), 1417 (1), 3274 (1); Cuadros 2239 (1), Cuatrecasas 20002 (1), 24295 (1); Curran 789 (1), 1341 (1), 2266 (1).

D'Arcy 4030 (1), 6705 (1), 9512 (1); Davidse 17838 (1), 32588 (1), 32622 (1); Dávila 397 (1); Degener 18738 (1); Delascio 11374 (2); Delprete 6333 (1); Del Carpio 2125 (2), 2251 (2); Den Outer 930 (1); Desvaux (1); Devia 2926 (1); Diaz 5172 (2); Dickson 851 (1); Dionizio 3360 (2); Dobbeler 5218 (1); Dodge 16727 (1); Dodson 2984 (2), 14569 (1); Don 25 (1); D'Orbygny s.n. (3); Dorr 9100 (1); Duarte 569 (2), 2284 (2); Duchafraing s.n. (1); Ducke 1565 (2); Dugand 743 (2); Duke 5759 (1), 6636 (1), 8477 (1), 10995 (1); Dusén 3005 (2), 7781 (2), 14025 (2); Duss 7 (1), 1867 (1), 2840 (1); Dwyer 11 (1), 1013 (1), 14999 (1).

Eggers 836 (1), 1155 (1), 2676 (1), 6510 (1); Egler 46056 (2); Eiten 1649 (2); Ekman 8053 (1); Elias 295 (2), 371 (1), 517 (1), 585 (1), 1291 (1), 1697 (1); Encarnación Mejía, (2); Espina 2097 (2), 2453 (1); Eyerdam 321 (1), 559 (1).

Feddema 2026 (1); Fendler 257 (1), 619 (1); Fernández 357 (1); Fernández-Casas 5874 (2), 10638 (1); Feuillet 892 (1), 1586 (1); Fiebrig 6451 (2); Florschüt 914 (1), 1677 (1); Fonnegra 7233 (2); Fortunato 2429 (2), 2811 (3); Fredholm 3071 (1), 5573 (1); Frey 760 (2); Fróes 1886 (1), 23781a (2); Fryxell 2821 (1); Fuentes 220 (1), 996 (2), 1386 (2), 1589 (2), 2028 (2), 2464 (2); Fuertes 220 (1); Funk 8410 (2).

Garner s.n. (1); Gardner 6060 (1); Gaudichaud 85 (2); Gaumer 653 (1), 23335 (1); Gehrt 4741 (2); Gentry 1524 (1), 28373 (1), 9243 (2), 12741 (2), 18296 (2), 28373 (1), 32134 (2), 40726 (1), 51015 (1); 51387 (2); Gentle 826 (1), 3921 (1); Geyskes s.n. (1); Gillespie 1196 (1); Ginzberger 350 (2); Glaziou s.n. (2), 4082 (2), 4086 (2), 5941 (2), 16348 (2); Godoy s.n. (1); Gómez 20567 (1); Gómez-L. 397 (1)3862 (1), 5539 (1), 10186 (1); Goodal 263 (3); Graham 381 (2); Grainville 5153 (1), 5760 (1), 6850 (1); Grayum

3658 (1), 4042 (1); Greg 151 (2); Greenman 5986 (1); Grewal 267 (2), 296 (1); Guaglianone 408 (3); Guareco 566 (2); Guillén 2333 (2), 2853 (2), 2914 (2), 2937 (2), 3214 (2), 3484 (2); Gutiérrez 1643 (2), 1848 (2).

Haase 533 (2); Hahn 123 (1), 3525 (1), 3808 (1); Hammel 4572 (1), 5038 (1), 21886 (1); Hammit 189 (1), 193 (1); Hampshire 948 (1); Hansen 7931 (1); Harvey 3436 (2); Hassler 2470 (2), 3841 (2), 4174 (3), 5731 (2); Hatschbach 1792 (2), 6641 (2), 15449 (2), 18229 (2), 20503 (2), 25977 (2), 28217 (2), 65385 (2), 65647 (2); Haught 4752 (2), 4841 (1), 5416 (1); Hauman 3591 (2); Hayes 91 (1); Heriberto 313 (1); Hermann 427 (1); Herrera 277 (1), 559 (1); Heyde 468 (1); Hicken s.n. (3), 1619 (2); Hill 27161 (1); Hitchcock s.n. (1), s.n. (1), s.n. (1), 202 (1), 16713 (1); Hoffman 750 (1); Holdrigde 1222 (1); Hooker s.n. (1); Hostmann 494a (2), 831 (2); Howard 4941 (1); Hunter 70a (1); Huston 507 (1).

Ibañez 2141 (1); Idrobo 6572 (2); Irwin 286 (1); Isabelle, 6 (2).

Jack 5242 (1); Jaeger s.n. (1); Jahn 1217 (1), 1230 (1); Janzen 1177 (1); Jaramillo 15203 (1); Jardim 3725 (2); Jenman 6808 (2); Jiménez 1235 (1), 1429 (2), 1959 (1); Johnson 1153 (1), 1290 (1); Jonker-Verhoef 89 (1); Jordán 3 (2); Jörgensen 3450 (2), 4038 (3); Juncosa 2522 (1); Junk 59 (2).

Kermes, s.n. (3); Kiesling 9696 (2); Killen 6892 (2); Killip 533 (1), 26911 (2), 30464 (1), 33010 (1), 38622 (1), 39078 (1), 42500 (1), 42583 (1), 42954 (1), 43152 (1), 44215 (1), 44280 (1), 44509 (1); Kings 199 (1), 348 (1); Klug 762 (2), 1290 (2); Kramer 3130 (1); Krapovickas 13757 (3), 20246 (3); Krukoff 4500 (2), 5915 (2), 5931 (2).

Labat 89 (1); Lane s.n. (1); Lanjouw 1053 (1), 1070 (1), 1082 (2), 1087 (1), 1434 (2), 1469 (1), 1555 (2), 3178 (2), 3430 (2); Lasser 2833 (2), 3863 (1); Ledru 16 (1); Leewenberg 11600 (1), 11851 (1); Le Goff 83 (1); Leguillon s.n. (1); Lehmann 1000 (1); León 268 (2), 644 (2); Leonard 4176 (1), 4207 (1), 13916 (1); Lépiz 399 (1); Lescarboura 72 (1); Lewis 87 (1), 1862 (1); 37625 (2); Liesner 1923 (1), 13264 (2); Lindeman 5728 (2), 15597 (2); Linden 57 (1); Liogier 14529 (1); López 5798 (2); Lundell 62 (1), 1813 (1), 4055 (1); Lutz s.n. (2), 685 (2).

Maas 5548 (1); MacDougal 3435 (1); Madrigal 70 (1), 661 (1); Magaña 309 (1); Maguire 23596 (1); Martín-Ballesteros, 151 (1), 624 (1); Marulanda 1626 (2), 1627 (2); Mathews 171 (1); Mattos 8243 (2); Maxon 321 (1), 1996 (1); McDaniel 5145 (1); Meijer 332 (1); Mejía 406 (1); Meleady 219 (1); Melinon 293 (2); Mell s.n. (1); Mello 3494 (2); Mendoza 278 (2); Menéndez 97 (1); Mennega 166 (1); Mereles 2146 (2), 2265 (2), 3452 (2), 4062 (2); Miller s.n. (1); Millspaugh 974 (1); Mizoghuchi 2420 (2), 2426 (2); Molas 1098 (2); Moldenke 725 (1); Molina 2048 (1), 5208 (1), 6951 (1), 20648 (1); Moore 1007 (2); Moraes 1138 (2); Morales 3010 (1), 6558 (1), 7004 (1), 14599 (1); Moreno 13199 (1); Moreno 11989 (1), 12312 (1); Moretti 186 (1); Mori 20317 (2), 21218 (2); Morton 10002 (1); Mouret 229 (1); Nee 40175 (2); Nee 41657 (2).

Neill 4563 (1); Nelson 968 (1), 1154 (1), 4245 (1), 7854 (1), 8503 (1), 8741 (1), 8895 (1), 11118 (1), 15500 (1); Neto 2602 (2); Nevers de 4880 (1), 6441 (1), 6590 (1); Novelo 2976 (1), 3105 (1), 3618 (1).

Oldeman 32 (1), 796 (1), 1064 (1), 1396 (1); Orellana 858 (2); Ortiz 855 (2); Otero 157 (1).

Page s.n. (1), s.n. (1); Palmer 966 (1), 971 (1), 892 (1); Paul 13 (1); Pedersen 1004 (3), 5328 (2), 5375 (3), 8516 (2), 10839 (3); Pennell 35 (2), 3738 (2), 3956 (2); Persaud 212 (1); Peterson 6355 (1); Peterson 6667 (1), 6770 (1), 7129 (1); Petitbon 93 (1), 121 (2); Philcox 8045 (1); Pipoly 9038 (1), 15434 (2); Pires 757 (1), 1619 (1), 4301 (2), 6533 (2); Pittier 379 (1), 2629 (1), 4106 (1), 4359 (1), 6352 (1), 9903 (1), 10480 (1), 10887 (2), 14034 (1); Plée s,n, (1), s.n. (1), 17 (1); Plowman 7066 (2); Poeppig 2946 (1); Pohl 5170 (2), 11574 (1); Poiret s.n. (1); Poiteau s.n. (1); Pohl s.n. (2); Pöll s.n. (1); Poncy 1024 (1); Prance 2542 (2), 8032 (2);13714 (2), 14780 (2), 16747 (2); Prévost 702 (1), 747 (2), 3288 (1), 4103 (1); Proctor 3312 (1), 24219 (1), 35116 (1); Pulle s.n. (2); Pursell 8131 (2).

Quesada 685 (1); Questel s.n. (1), 4188 (1).

Rambo 34990 (2); Ramírez 4 (2); Ramos 113 (2); Ramsammy 2 (1); Raven 21514 (1); Raynal-Roques 19814 (1); Realpe, 170 (1); Reijenga 623 (2); Reitz 4949 (2), 14545 (2), 17622 (2); Renteria 4285 (1); Revilla 2043 (2); Reyes s.n. (1); Rimachi 6526 (2); Ritter s.n. (1), 1688 (2), 3763 (2), 4495 (2), 4631 (2); Robertson 254 (1); Rodríguez s.n. (2); 3118 (1), 3198 (1), 5584 (1); Rohr von 21 (1); Rojas 2095 (3); Roldán 516 (1); Romero 1574 (3); Romero-Castañeda 65 (1), 1635 (2), 1946 (1), 1925 (1), 6336 (2); Rondeau 456 (2); Rosa 4395 (2); Rudas 4263 (2); Rugel 114 (1), 694 (1); Rusby 20 (2); Rutten 204 (1).

Sachet 449 (1); Sáenz 5a (1); Sagra s.n. (1), s.n. (1), s.n. (1); Saint Hilaire 328 (2), 400 (2), 491 (2); Salas 1333 (1), 2761 (1); Saldías 572 (2), 2916 (2); Sandino 2199 (1), 2225 (1); Santa 343 (1); Santos 491 (2); Sargent 23 (1); Sastre 1020 (2), 4162 (1); Saunders 619a (1), 854 (1); Schinini 10299 (2); Schipp 148 (1); Schmalzel 316 (1), 1789 (1); Schmeda 1499 (2), 1590 (2); Schomburgk 329 (2); Schultes 7158 (2); Schulz 238 (3), 8388 (3), 10525 (1); Schunke 5 (2), 960 (2), 1019 (2), 6676 (2); Segura 213 (1); Seibert 1719 (1); Silva 168 (1), 2141 (2); Simmuels 448 (1); Simpson 252 (1); Sintenis 935 (1), 935c (1); Small s.n. (1), 4591 (1); Smith 776 (2), 998 (2), 1080 (1), 1664 (1), 8305 (2), 9465 (2), 11077 (2), 11588 (2), 12881 (1); Sobel 4839 (2); Solabarrieta 100 (1); Soria 1820 (2); Soto s.n. (1), s.n. (1), 485 (1), 748 (1), 822 (1), 1074 (1), 3393 (1); Sousa 10867 (1); Spegazzini s.n. (2); Spellman 1443 (1), 2432 (1); Splitgerger s.n. (2); Spruce s.n., (1), 516 (2); Standley 373 (1), 20059 (1), 24827 (1), 25141 (1), 28748 (1), 31133 (1), 72863 (1); Steere 1910 (1), 1937 (1); Stehlé 4562 (1); Stergios 1375 (1); Sterringa 12418 (1); Stevens 1044 (1), 7870 (1), 10465 (1), 17765 (1), 19619 (1), 20043 (1), 20665 (1); Stevenson 433 (1), 1357 (2); Steyermark 87705 (1); 94620 (2), 107867 (1), 108393 (1), 110529 (1), 110893 (1), 114584 (2), 114842 (2), 114982 (1), 115321 (2), 120423 (2); Stier 4 (1), 61 (1); Stoddart 7014 (1), 7039 (1); Strudwick 3349 (2), 3936 (2), 4131 (2).

Tamayo 4730 (1); Taylor 1055 (1); Tejera 209 (2); Téllez 2050 (1), 2238 (1); Tenorio 14941 (1); Tessmann 3547 (2), 3668 (2); Teunissen 13201 (2), 15105 (2); Thomas 4563 (2); Thoms 2 (1); Thorne 14935 (1); Toledo 284 (2), 578 (2); Tonduz 7081 (1); Townsend 39 (2); Triana 3409-11 (1); Trinta 1029-2105 (2); Tsugaru 2263 (2); Tun 126 (1); Tyson 4670 (1), 6806 (1).

Utley 39 (1).

Vanni 1226 (2); Vargas 595 (2), 6675 (2); Vreden 14075 (1).

Wacket s.n. (2); Walter 1107 (1); Webster 10410 (1); Wedel 496 (1), 591 (1), 1546 (1), 1978 (1); Weissenhofer 35 (1); Went, 334 (1), 573 (1); Wessels 507 (1); White 39 (1), 1522 (2); Wilbur 23973 (1), 32827 (1); Wiley 143 (1); Williams 15539 (1); Willemse 1 (1); Wilson 244 (1), 264 (1); Wood 13216 (2), 17363 (2); Woodroffe 602 (1); Woodson 764 (1), 933 (1), 1682 (1); Woolston 483 (3); Worthing, 21223 (1); Wright 2594 (1); Wullschlägel 326 (2), 342 (1); Wurdack 323 (1), 41391 (2); Wydler s.n. (1).

Vanni 1226 (2), 4133 (3); Vargas 595 (2); Vásquez 923 (2), 4373 (2), 12716 (2); Vélez 2735 (2); Vincelli 652 (1), 668 (1), 670 (1), 670a (1); Vreden 14075 (1).

Yepes 27 (1); Yuncker 17961 (1).

Zainum 16Bo080 (2); Zardini 10815 (3), 17209 (3), 18744 (3), 37523 (2), 37786 (3), 41979 (2), 42854 (2); 44707 (2), 45517 (2), 46237 (3), 46399 (3), 47263 (2), 47281 (2), 47799 (2), 48138 (2), 51849 (3), 52758 (2), 53938 (2), 54670 (2), 55634 (3), 55892 (2), 56502 (2), 56633 (2), 56637 (2), 56910 (2), 57613 (3); 59320 (2), 59381 (2), 59888 (2). Zuloaga 1485 (2), 3128 (3), 3145 (2).

APÉNDICE 3

ÍNDICE DE NOMBRES COMUNES

bejuco lechero (*R. biflora*, Venezuela, Monagas)
cai seca (*R. biflora*, Brasil, Para, Marajo)
cipó de caraugrejo (*R. biflora*, Brasil, Maranhao)
dub inanusu (*R. biflora*, Panamá, San Blas, nombre kuna)
huevo de gato (*R. madida*, Perú, Loreto, Bella Vista)
lecho de mar (*R. biflora*, Colombia, Nariño, Tumaco)
liane mangle (*R. biflora*, Guyana Francesa, Cayenne, Mahury)
mangrove vine (*R. biflora*, Belice, ciudad de Belice)
palo de leche (*R. biflora*, República Dominicana)

AGRADECIMIENTOS

Quiero agradecer a los herbarios A, AAU, ALCB, AS, ASE, B, BAB, BEREA, BHCB, BIGU, BM, BOLV, BR, C, CAS, CAY, CEN, CEPEC, CGE, CHAPA, CICY, CIIDIR, CIMI, CM, COAH, COL, CR, CVRD, CUVC, CUZ, DPU, DS, DUKE, E, EAP, ECON, ENCB, ESA, ESAL, F, FCQ, FDG, FI, FI-W, FUEL, G, G-BOIS, G-DC, GB, GFJP, GH, HAL, HB, HBG, HERZU, HOXA, HRB, HRCB, HST, HUA, HUEFS, HUQ, IAN, IBGE, INPA, IPA, JAUM, JEPS, JPB, K, LAGU, LD, LE, LIL, LP, LPB, LZ, M, MA, MBM, MBML, MEDEL, MEXU, MG, MHES, MICH, MO, MOL, NY, O, P, P-BA, P-HB, P-JU, P-LA, PEL, PEUFR, PMA, PORT, PR, Q, QAME, QAP, QCA, QCNE, QPLS, R, RB, S, SI, SP, SPF, SPFR, TEFH, TRIN, TULV, U, UB, UC, UCOB, UDCB, UFMT, UFP, UPS, US, USF, USJ, USM, USZ, UVAL, W, WU, WAG, WIS, VALLE, VALLE, VEN, VIC, XAL, Z, y ZT por proveer material en préstamo o por facilitar el acceso a sus colecciones, así como a los herbarios BHCB, ESA, LAGU, MO, UVAL por el numeroso envío de material como regalo por identificación. Se agradece la colaboración de Michael Grayum (MO), quien suministró referencias bibliográficas claves y colaboró en la tipificación de algunos taxones, así como a Barry Hammel (MO), quien revisó y corrigió el resumen en inglés. Se desea reconocer de manera muy especial las atenciones y las facilidades brindadas por Paul Maas e Hiljte Maas (U), que hicieron posible la visita de varios herbarios en Holanda. Otras personas a las que quiero expresar mi gratitud por brindar facilidades logísticas que facilitaron la visita de varios herbarios en Centro y Sur América son Alessandro Rapini (HUEFS), Alfredo Fuentes (USZ), Alvaro Cogollo (JAUM), Ana Luc McVean (UVAL), Andre Amorin (CEPEC), Andre Fontana (MBML), Asunción Cano (USM), Cirilo Nelson (TEFH), Eunice Echeverría (MHES), Frank Sullyvan Cardoza (EAP), Gabriela Jolochin (MVFA), Homero Vargas (QCNE), Joaquina Albán (USM), Jorge Monterrosa (LAGU), Julio Betancur (COL), Marccus Alves (UFP), Mario Véliz (BIGU), Mauricio Bonifacino (MVFA), Norma Degninani (SI), Phillip Silverstone-Soukup (CUVC), Reneé Fortunato (BAA), Ricardo Callejas (HUA), Rocío Rojas (HOXA), Rodolfo Vásquez (MO) y Stephan Beck (LPB). Finalmente, quiero agradecer de manera muy especial al personal de los herbarios de la Universidad de Antioquia (HUA) y del Jardín Botánico Javier Antonio Uribe (JAUM), en Medellín, Colombia, por las facilidades brindadas y el excelente trato humano brindado en mis continuas visitas a esa ciudad. Mary E. Endress y un revisor anónimo contribuyeron con la revisión del manuscrito.

REFERENCIAS

Beurling, P.J. 1856. Primitiae florae portobellensis. Kongl. Vetensk. Acad. Handl. 1854:107–148.

Britton, N.L. and C.F. Millspaugh. 1920. The Bahama flora. N.L. Britton & C.F. Millspaugh, New York, United States. 694 pp.

Endress, M. and P. Bruyns. 2000. A revised classification of the Apocynaceae s.l. Bot. Rev. (Lancaster) 66:1–56

Endress, M., S. Liede-Schumann and U. Meve. 2007. Advances in Apocynaceae: The enlightenment, an introduction. Ann. Missouri Bot. Gard. 94:259–267.

Ezcurra, C., 1981. Revisión de las Apocináceas de la Argentina. Darwiniana 23:367–474.

Ezcurra, C., M. Endress, and A.J.M. Leeuwenberg. 1992. Apocynaceae. En: R. Spichiger & L. Ramella, eds. Fl. Paraguay 17:1–121.

Fahn, A. 1979. Secretory tissues in plants. Academic Press Inc., London, England.

Hansen, B.F. 1985. A monographic revision of *Forsteronia* (Apocynaceae). Ph.D. dissertation. University of South Florida. U.S.A. [University Microfilms International, Ann. Arbor.]

Leeuwenberg, A.J.M. 1994a. A revision of *Tabernaemontana* Two. The New World species and *Stemmadenia*. Royal Botanic Gardens, Kew, England. 213–450 pp.

Leeuwenberg, A.J.M. 1994b. Taxa of the Apocynaceae above of the genus level. Agric. Univ. Wageningen Pap. 94:45–60.

Livshultz, T., D.J. Middleton, M.E. Endress, and J.K. Williams. 2007. Phylogeny of Apocynoideae and the APSA clade (Apocynaceae s.l.). Ann. Missouri Bot. Gard. 94:324–359.

Miers, J. 1878. On the Apocynaceae of South America. Williams & Norgate, London, Edinburgh, England.

Monachino, J. 1958. Apocynaceae. En: B. Maguire, J. Wurdack y colaboradores, eds. The botany of the Guayana Highland III. Mem. New York Bot. Gard. 10:117–138.

Morales, J.F. 1997. A synopsis of the genus *Prestonia* (Apocynaceae) section *Tomentosae* in Mesoamerica. Novon 7:59–66.

Morales, J.F. 1998. A synopsis of the genus *Mandevilla* (Apocynaceae) in Mexico and Central America. Brittonia 50:214–233.

Morales, J.F. 1999. A synopsis of the genus *Odontadenia* (Apocynaceae), Series of revisions of Apocynaceae XLV. Bull. Jard. Bot. Nat. Belg. 67:381–477.

Morales, J.F. 2004. Estudios en las Apocynaceae Neotropicales VII: Novedades taxonómicas en *Prestonia* (Apocynaceae, Apocynoideae) para Colombia y Ecuador, con comentarios sobre el grado de lobulación del nectario. Candollea 59:159–165.

Morales, J.F. 2005. Estudios en las Apocynaceae neotropicales XIX: La familia Apocynaceae (Rauvolfioideae, Apocynoideae) en Costa Rica. Darwiniana 43:90–191.

Morales, J.F. 2006. Estudios en las Apocynaceae Neotropicales XXIV: *Bahiella* (Apocynoideae: Echiteae) un desapercibido género endémico de Bahia, Brasil. Sida 22:333–353

Morales, J.F. 2007. Estudios en las Apocynaceae Neotropicales XXXI: el complejo de *Mandevilla hirsuta* y cuatro nuevas especies. J. Bot. Res. Inst. Texas 1:859–869.

Morales, J.F. and A. Fuentes. 2004. Estudios en las Apocynaceae Neotropicales VIII: nuevas especies de *Mandevilla* (Apocynoideae, Mesechiteae) para Perú y Bolivia, con notas sobre la morfología floral en corolas infundibuliformas. Candollea 59:167–174.

Müller Argoviensis, J. 1860a. Apocynaceae. En: C.F.P. von Martius (ed.), Flora Brasiliensis 6(1):1–180.

Müller Argoviensis, J. 1860b. Species novae nonnullae americanae ex ordine Apocynearum et observationes quaedam in species generis Echites auctorum earumque distributio in genera emendata et nova. Linnaea 30:387–454.

Pichon, M. 1948 a. Classification des Apocynacées. I. Carissées et Ambelaniées. Mém. Mus. Natl. Hist. Nat., Sér. B., Bot. 24:111–181.

Pichon, M. 1948 b. Classification des Apocynacées. V. Cerbéroïdées. Not. Syst. Paris 13:212–229.

Pichon, M. 1948 c. Classification des Apocynacées. XIX. Le rétinacle des Echitoïdées. Bull. Soc. Bot. France 95:211–216.

Pichon, M. 1949. Classification des Apocynacées. IX. Rauvolfiées, Alstoniées, Allamandées et Tabernaémontanoidées. Mém. Mus. Natl. Hist. Nat. 27:153–251.

Pichon, M. 1950a. Classification des Apocynacées. XXV. Echitoïdées. Mém. Mus. Natl. Hist. Nat., Sér. B., Bot. 1:1–143.

Pichon, M. 1950b. Classification des Apocynacées. XXVIII. Supplément aux Plumérioïdées. Mém. Mus. Natl. Hist. Nat., Sér. B., Bot. 1:145–173.

Simões, A.O. and L.S. Kinoshita. 2002. The Apocynaceae s. str. of the Carrancas region, Minas Gerais, Brazil. Darwiniana 40:127–169.

Simões, A.O., M. Endress, T. van der Niet, L.S. Kinoshita, and E. Conti. 2004. Tribal and intergeneric relationships of Mesechiteae (Apocynoideae, Apocynaceae): evidence from three noncoding pastid DNA regions and morphology. Amer. J. Bot. 1:1409–1418.

Simões, A.O., M. Endress, T. van der Niet, L.S. Kinoshita, and E. Conti. 2006. Is *Mandevilla* (Apocynaceae, Mesechiteae) monophyletic? Evidence from five plastid DNA loci and morphology. Ann. Missouri Bot. Gard. 93:565–591.

Simões, A. O., T. Livshultz, E. Conti, and M.E. Endress. 2007. Phylogeny and systematics of the Rauvolfioideae (Apocynaceae) based on molecular and morphological evidence. Ann. Missouri Bot. Gard. 94:268–297.

Williams, J. 2004. Polyphyly of the genus *Echites* (Apocynaceae: Apocynoideae: Echiteae): evidence based on a morphological cladistic analysis. Sida 21:117–131

Woodson, R. 1935 a. Observations on the inflorescence of Apocynaceae (with special reference to the American genera of Echitoideae). Ann. Missouri Bot. Gard. 22:1–48.

Woodson, R. 1935 b. Studies in the Apocynaceae. IV. The American genera of Echitoideae XXVI. Ann. Missouri Bot. Gard. 22:153–306.

Woodson, R. 1936. Studies in the Apocynaceae. IV. The American genera of Echitoideae. Ann. Missouri Bot. Gard. 23:169–438.

Woodson, R. 1940. Una nueva especie santafecina de *Rhabdadenia*. Lilloa 5:199–200.

ESTUDIOS EN LAS APOCYNACEAE NEOTROPICALES XXXVIII: TRES NUEVAS ESPECIES DE *MANDEVILLA* (APOCYNOIDEAE: MESECHITEAE) PARA COLOMBIA Y VENEZUELA

J. Francisco Morales

Instituto Nacional de Biodiversidad (INBio), Apto 22--3100
Santo Domingo de Heredia, COSTA RICA
fmorales@inbio.ac.cr

RESUMEN

Se describen e ilustran **Mandevilla albifolia, M. caquetana** y **M. sanctae-martae,** tres nuevas especies de Venezuela y Colombia y se discuten sus relaciones con especies afines.

Palabras clave: Apocynaceae, Apocynoideae, Mesechiteae, *Mandevilla*, Colombia, Venezuela

ABSTRACT

Mandevilla albifolia, M. caquetana, and **M. sanctae-martae,** three new species endemic to Venezuela and Colombia are described and illustrated and their relationships with related species are discussed.

Trabajando en la preparación de las Apocynaceae para el Catálogo de las Plantas de Colombia y Venezuela, se describen tres nuevas especies, dos de ellas endémicas para Colombia y la última conocida solo del estado del Táchira en Venezuela. En las descripciones, las partes de la corola siguen a Morales (2005).

Mandevilla albifolia J.F. Morales, sp. nov. (**Fig. 1**). Tipo: VENEZUELA. Táchira: Uribante, Siberia, camino a Pregonero, 20 nov 1985 (fl, fr), *van der Werff & Ortega 8086* (holotipo: INB, isotipos: MO, WAG).

A *Mandevilla caquetana* J.F. Morales et *Mandevilla obtusifolia* Monach. cui similis, foliis linearis vel ellipticus-linearis et subtus glaucus differt.

Liana; ramitas aplanadas cuando jóvenes, cilíndricas a subcilíndricas con la edad, usualmente sólidas, diminuta y densa a moderadamente papilado-puberulentas, el indumento más esparcido con la edad; coléteres interpeciolares inconspicuos, hasta 0.8 mm de largo. Hojas opuestas; pecíolos 2.7–4.5 mm de largo; láminas foliares 4.5–9.5 × 0.4–0.7(–0.8) cm, lineares a linear-elípticas, el ápice mucronulado-acuminado, la base cuneada a obtusa, los coléteres irregularmente distribuidos a lo largo del nervio central, membranáceas, glabras en la superficie adaxial, densamente glauco-tomentosas abaxialmente, el indumento no visible a simple vista, el margen no revoluto, las venas secundarias apenas visibles abaxialmente, inconspicuas en la superficie adaxial, venas terciarias no impresas. Inflorescencia más corta o igualando las hojas subyacentes, axilar, esparcidamente puberulenta a glabrescente, el indumento restringido mayormente al eje, con muchas flores, pedúnculo 4–17 mm de largo, pedicelos 3–4.2 mm de largo, brácteas 1–3 × 0.7–1.3 mm, linear-ovadas, escariosas; sépalos 1.1–1.4 × 1–1.2 mm, similares en longitud, angostamente ovados, acuminados apicalmente, el ápice no reflexo, escariosos, glabros o glabrescentes externamente, el coléter solitario, irregularmente laciniado apicalmente; corola infundibuliforme, amarilla o anaranjado-amarilla, glabra externamente, el tubo basalmente giboso, la parte inferior 6.5–7.6 × 1.5–2.1 mm, la parte superior 13–14 mm de largo, campanulada, 9–10 mm de diámetro en el orificio, el ápice del botón floral obtuso a redondeado; lóbulos 13–15 × 9–10 mm, obovados, aparentemente extendidos; estambres insertos en la base de la parte superior del tubo, anteras 3.5–4 mm de largo, glabras dorsalmente, la base auriculada, con las aurículas agudas, cabeza estigmática 1.4–1.7 mm de largo; ovario 1–1.3 mm de largo, glabro; nectario anular, moderadamente pentalobulado, ca. la mitad de la longitud del ovario. Folículos 15.3–20.8 cm × 1–3 mm, no fusionados longitudinalmente, algunas veces solo unidos en el ápice, glabros, moniliformes; semillas 8–9 mm de largo, glabras a glabrescentes, la coma 1.3–1.9 cm de largo, canela-amarilla.

J. Bot. Res. Inst. Texas 3(2): 565 – 571. 2009

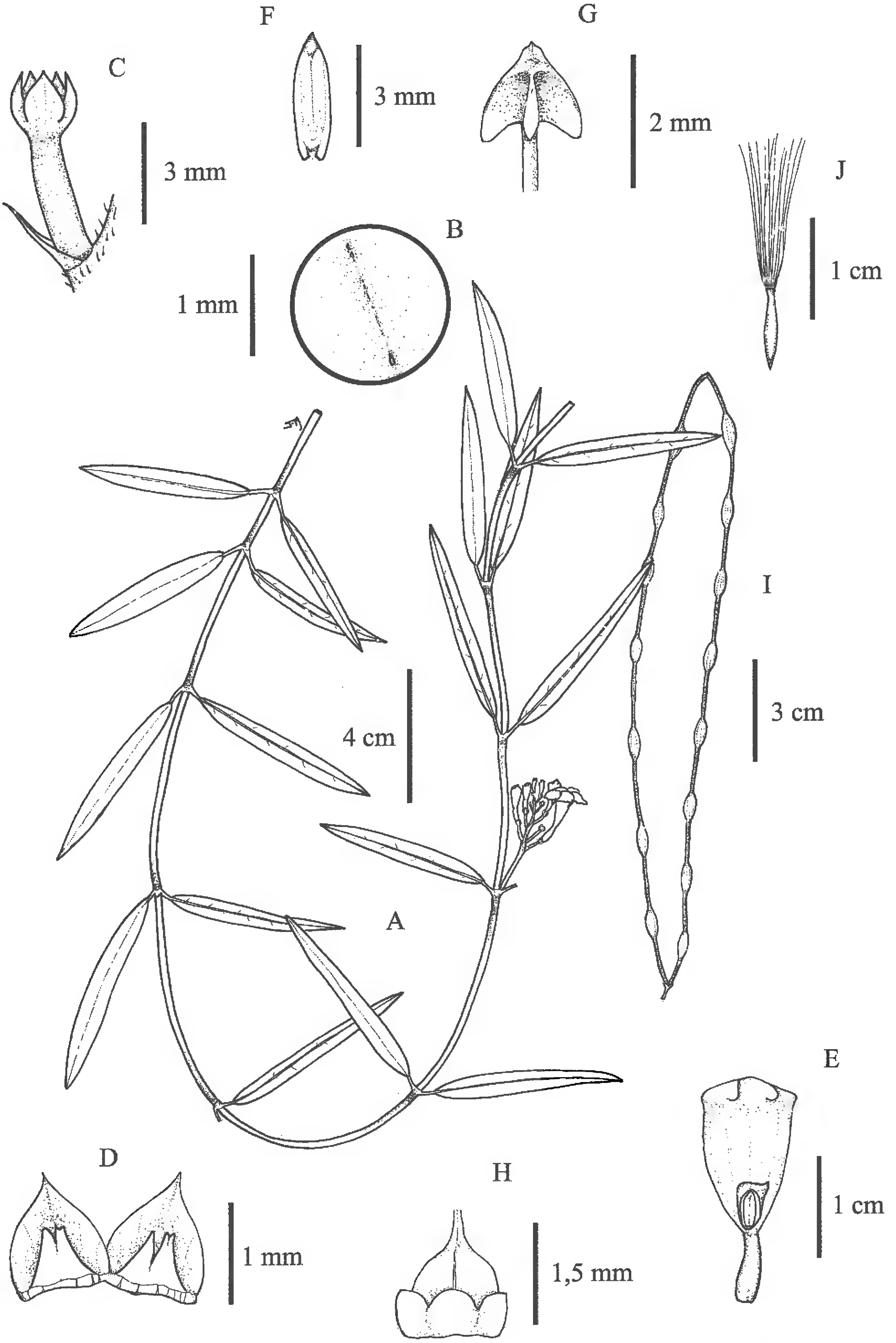


Fig. 1. *Mandevilla albifolia* (A–H de *van der Werff & Ortega 8086*, INB; I–J de *Maas & Tillet 5273*, WAG). **A.** Ramita con flores. **B.** Detalle de la superficie adaxial de la hoja, mostrando los coléteres a lo largo del nervio central. **C.** Cáliz, pedicelo y bráctea. **D.** Vista adaxial de dos sépalos y coléteres. **E.** Tubo de la corola parcialmente abierto, mostrando la posición de las anteras y el tubo giboso en la base. **F.** Antera, vista dorsal. **G.** Cabeza estigmática. **H.** Nectario y ovario. **I.** Folículos. **J.** Semilla.

Distribución, hábitat y ecología.—Endémica al estado de Táchira, Venezuela, donde crece en vegetación secundaria y vegetación asociada a sabanas, en elevaciones de 600–1300 m. Flores se producen de mayo a agosto y noviembre. Frutos se han recolectado en junio, julio y noviembre.

Mandevilla albifolia se encuentra relacionada con *M. caquetana*, *M. obtusifolia* y *M. pachyphylla* Woodson, un grupo de taxones que se reconocen por sus inflorescencias con las brácteas florales escariosas y láminas foliares con la venación secundaria levemente impresa y las venas terciarias no impresas. Sin embargo, *M. albifolia* se puede diferenciar de estas especies por sus láminas foliares lineares a linear-elípticas, con la superficie abaxial glauco-tomentosa.

Especímenes examinados: **VENEZUELA. Táchira:** carretera Fundación–Siberia, sector La Idea, 17 Ago 1988 (fl), *Badillo et al. 7912* (F, MY); Uribante, camino a Presa La Honda, 24 Jun 1990 (fl, fr), *Dorr & Barnett 7177* (VEN); E de La Fundación, represa Dorada, 1 May 1981 (fl), *Liesner et al. 11649* (INB, MO, VEN); La Fundación, camino a Pregonón, 13 nov 1980 (fl, fr), *Maas & Tillet 5273* (WAG); Cerro Las Minas, SE de Santa Ana, 10 nov 1979 (fl), *Steyermark et al. 119835* (MO, VEN); Uribante, cerca de La Fundacion, 6 Jul 1983 (fl, fr), *van der Werff 4902* (MO, VEN).

Mandevilla caquetana J.F. Morales, sp. nov. (**Fig. 2**). Tipo: COLOMBIA. Caquetá: Solano, sabanas del Yari, Chorro de la Gamitana, 7–14 abr 1997 (fl), *Arbeláez et al. 832* (holotipo: INB; isotipos: COAH, HUA).

A *Mandevilla obtusifolia* Monach. cui similis, petiolis 1–2.5 mm longis (vs. 4–5 mm), pedicelis 1–1.5 mm longis (vs. 3 mm), corollae tubo 20–23 mm longis (vs. 45 mm) et faucibus 5–6 mm diametro (vs. 15 mm) differt.

Liana; ramitas cilíndricas a subcilíndricas, sólidas, no huecas, densa a moderadamente puberulentas a papilado-puberulentas; coléteres interpeciolares inconspicuos, hasta 0,6 mm de largo. Hojas opuestas; pecíolos 1–2.5 mm de largo; láminas foliares 1.5–4 × 1–2.9 cm, elípticas, el ápice redondeado-mucronado, más raramente emarginado-mucronado, la base cordada, los coléteres distribuidos irregularmente a lo largo del nervio central, membranáceas, glabras, levemente revolutas marginalmente, venación secundaria impresa en ambas superficies, las venas terciarias no evidentes. Inflorescencia igualando o ligeramente más larga que las hojas subyacentes, axilar, inconspicua y esparcidamente puberulenta a glabrescente, con muchas flores, pedúnculo 18–21 mm de largo, pedicelos 1–1.5 mm de largo, brácteas 1.5–2 × 0.5–1 mm, angostamente ovadas a linear-ovadas, escariosas; sépalos 1–1.5 × 1–1.2 mm, angostamente ovados, similares en longitud, cortamente acuminados apicalmente, el ápice no reflexo, escariosos, glabros a glabrescentes externamente, el coléter solitario, subentero a diminuta e irregularmente lacerado apicalmente; corola infundibuliforme, amarillo-verdosa, glabra externamente, el tubo giboso basalmente, la parte inferior 12–13 × 1.4–2.1 mm, la parte superior 8–10 mm de largo, cónica, con un diámetro de 5–6 mm en el orificio, el ápice del botón floral obtuso-apiculado o redondeado-mucronulado; lóbulos 5–6.5 × 4–5.4 mm, obovados, extendidos; estambres insertos en la base de la parte superior del tubo, anteras 2.9–3.2 mm de largo, glabras dorsalmente, la base auriculada, con las aurículas obtusas a redondeadas; cabeza estigmática 1–1.3 mm de largo; ovario 1–1.3 mm de largo, glabro; nectario anular, irregularmente lobulado, ca. la mitad de la longitud total del ovario. Folículos 8.3–10 cm × 1–4 mm, no fusionados longitudinalmente, algunas veces solo unidos en su región apical glabros, moniliformes; semillas desconocidas.

Distribución, hábitat y ecología.—Endémica al Departamento de Caquetá, en la Amazonia Colombiana, donde crece en vegetación asociada a afloramientos rocosos de cuarzita del escudo Guyanes (sierra de Chiribiquete), en elevaciones de 350–750 m. Especímenes con flores han sido recolectados en abril y de noviembre a diciembre. Material con frutos se conoce en agosto y de noviembre a diciembre.

Mandevilla caquetana pertenece al subgénero *Exothostemon* (sensu Woodson, 1933) y ha sido confundida con *M. obtusifolia*, taxón endémico al Estado de Amazonas, Venezuela y conocido hasta el momento solo por la colección tipo, la cual se perdió en 1978 durante un envío de material del New York Botanical Garden a Venezuela. Sin embargo, basado en la extensa descripción original y en las ilustraciones que la acompañan (Monachino, 1961), *M. caquetana* se puede distinguir con facilidad de esa especie por la siguiente combinación de caracteres: hojas cortamente pecioladas, con los pecíolos 1–2.5 mm de largo (vs. 4–5 mm), láminas foliares con la base conspicuamente cordada (vs. redondeada y subcordada), flores cortamente pediceladas,

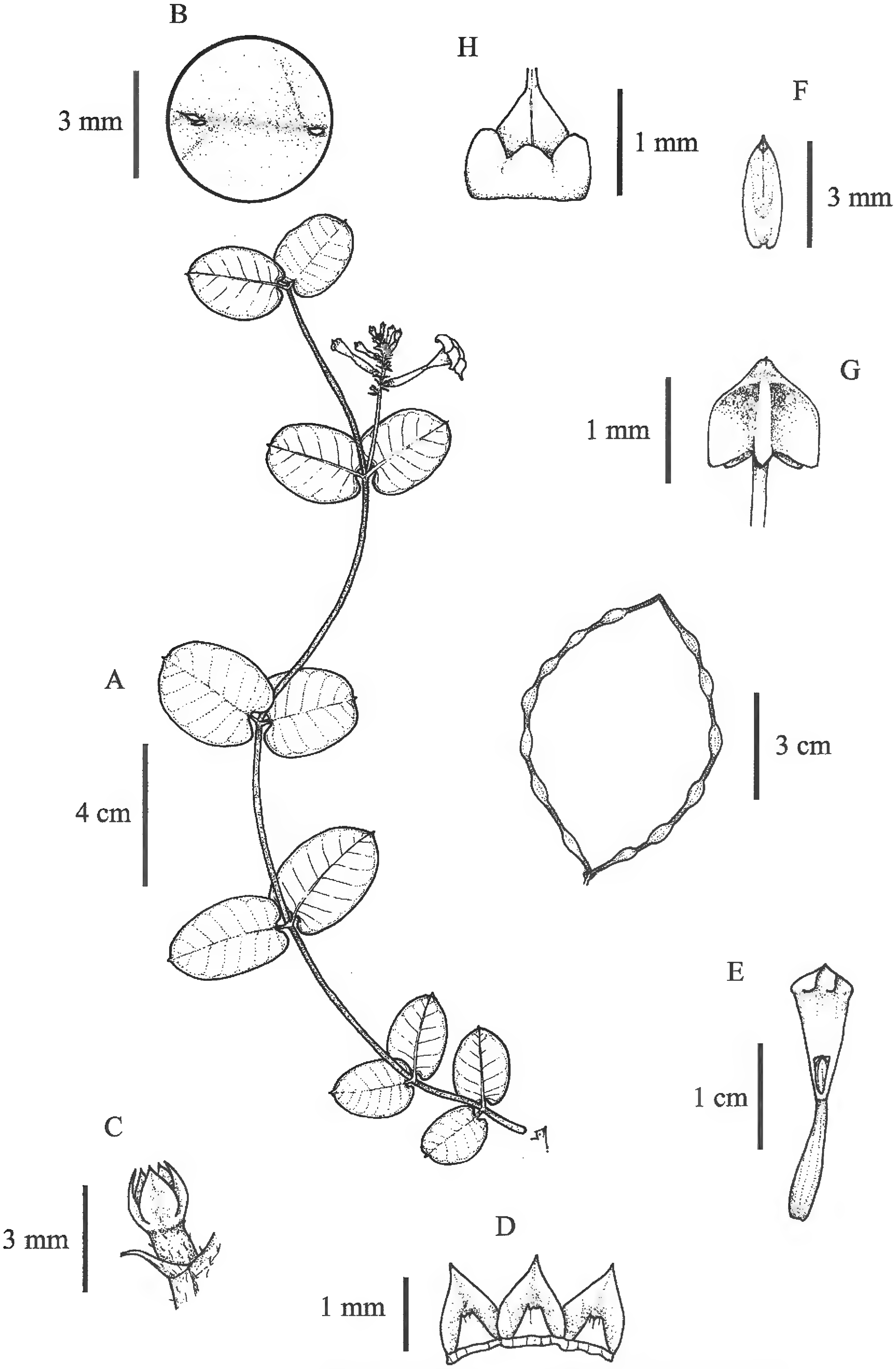


Fig. 2. *Mandevilla caquetana* (A–H de *Arbeláez et al. 832*, INB; I de *Cardiel et al. 1021*, MA). **A.** Ramita con inflorescencias. **B.** Detalle de la superficie adaxial de la hoja, mostrando los coléteres a lo largo del nervio central. **C.** Cáliz, pedicelo y bráctea. **D.** Vista adaxial de tres sépalos y coléteres. **E.** Tubo de la corola parcialmente abierto, mostrando la posición de las anteras y el tubo giboso en la base. **F.** Antera, vista dorsal. **G.** Cabeza estigmática. **H.** Nectario y ovario. **I.** Folículos.

con los pedicelos de 1–1.5 mm de largo (vs. 3 mm), sépalos 1–1.5 mm de longitud (vs. 2.5 mm), corolas con la parte inferior del tubo de 12–13 mm de longitud (vs. 30 mm) y la parte superior de 8–10 mm de largo (vs. 25 mm), con un diámetro de 5–6 mm (vs. 15 mm) en el orificio y anteras ligeramente más cortas, de 2.9–3.1 mm de largo (vs. 4.3 mm).

Especímenes examinados: **COLOMBIA. Caquetá:** serranía norte, 26 nov 1992 (fl), *Barbosa & Rueda 8084* (COL); sierra de Chiribiquete, campamento Norte, 6 Dic 1990 (fr), *Cardiel et al. 1021* (COL, MA [2 cartulinas]); sierra de Chiribiquete, campamento Norte, 7 Dic 1990 (fl, fr), *Castroviejo et al. 11989* (COL, MA); sierra de Chiribiquete, 19 nov 1992 (fl), *Franco et al. 4127* (COL, MA); sierra de Chiribiquete, campamento sur, 11 Dic 1990 (fl), *Fuertes et al. 1144* (COL); sierra de Chiribiquete, 10 Dic 1990 (fl), *González et al. 2286* (COL, MA); sierra de Chiribiquete, cueva de las Pinturas, 21 Ago 1992 (fr), *Palacios et al. 2404* (COAH, COL, P); sin localidad precisa, 26 nov 1992 (fr), *Velayos et al. 6386* (COL).

Mandevilla sancta-martae J.F. Morales, sp. nov. (**Fig. 3**). Tipo: COLOMBIA. Magdalena: Sierra Nevada de Santa Marta, al E de quebrada Indiana, 1 sep 1972 (fl), *Kirkbride 2049* (holotipo: INB; isotipos: COL, NY, US).

A *Mandevilla schlimii* (Müll. Arg.) Woodson cui similis, foliiis glabris (vs. tomentosis), tubo proprio 17–18 mm (vs. 10–14 mm) et faucibus 16–17 mm diametro (vs. 8–10 mm) differt.

Liana; ramitas cilíndricas a subcilíndricas, a veces algo aplanadas antes de los nudos en ramitas tiernas, sólidas, glabras; coléteres interpeciolares inconspicuos, hasta 0,6 mm de largo. Hojas opuestas; pecíolos 11–17 mm de largo; láminas foliares 5.5–10.2 × 1.8–3.7(–4.1) cm, elípticas a ovado-elípticas, el ápice largamente acuminado, la base cordada, los coléteres irregularmente distribuidos a lo largo del nervio central, membranáceas, glabras, no bulladas, el margen no revoluto, las venas secundarias y terciarias impresas en ambas superficies, pero usualmente las venas terciarias algo inconspicuas en la superficie adaxial, con domacios diminutos a lo largo del nervio central abaxialmente. Inflorescencia igualando a más larga que las hojas subyacentes, axilar, glabra, con relativamente pocas flores (hasta 12), pedúnculo 10–17 mm de largo, pedicelos 3–5 mm de largo, brácteas 3–6 × 0.6–0.9 mm, angostamente ovadas, escariosas; sépalos 3.2–4.5 × 1.1–1.5 mm, angostamente ovados, similares en longitud, el ápice acuminado, no reflexo, escariosos, glabros externamente, el coléter solitario, subentero o irregularmente lacerado; corola infundibuliforme, amarilla, los botones con manchas rojizas, glabra externamente, el tubo algo giboso en la base, la parte inferior 9–10 × 3.7–5 mm, la parte superior 17–18 mm de largo, anchamente campanulada, con un diámetro en la boca de 16–17 mm, el ápice del botón floral anchamente agudo a obtuso; lóbulos 16–21 × 12–16 mm, obovados, aparentemente apenas extendidos; estambres insertos en la base de la parte superior del tubo, anteras 4.8–5.2 mm de largo, glabras dorsalmente, la base auriculada, con las aurículas subtruncadas, cabeza estigmática 2–2.2 mm de largo; ovario 1.2–1.4 mm de largo, glabro; nectario anular, pentalobulado, ca. la mitad de la longitud del ovario. Folículos desconocidos.

Distribución, hábitat y ecología.—Endémica al Departamento de Magdalena en Colombia, donde crece en bosques muy húmedos en la Sierra Nevada de Santa Marta en elevaciones de 1600–1700 m. Especimenes con flores han sido recolectados entre agosto y septiembre.

Mandevilla sanctae-martae puede ser confundida con *M. schlimii* (Müll. Arg.) Woodson, pero se puede reconocer por sus corolas con la parte superior del tubo 17–18 mm de largo y con un diámetro de 16–17 mm en la boca (vs. 10–14 mm de largo y 8–10 mm de diámetro), láminas foliares con la superficie abaxial glabra y con domacios a lo largo del nervio central en la superficie abaxial (vs. glauco-tomentosas y sin domacios). Otro grupo de especies relacionadas incluyen a *M. mollissima* (Kunth) Woodson, *M. scabra* (Hoffmanns. ex Roem. & Schult.) K. Schum., *M. speciosa* (Kunth) J.F. Morales y *M. symphitocarpa* (G. Mey.) Woodson, pero *M. sanctae-martae* se puede separar de estas especies por la presencia de domacios en sus hojas y corolas con la parte inferior del tubo inferior a 1 cm de largo. El epíteto de esta especie hace referencia a la Sierra Nevada de Santa Marta en Colombia, una zona con un alto índice de endemismo.

Especímenes examinados: **COLOMBIA. Magdalena:** Sierra Nevada de Santa Marta, quebrada Botella, camino a San Pedro de la Sierra, 29 sep 1972 (fl), *Kirkbride 2277* (COL, US); camino de San Javier a San Andrés, por el filo del Cerro Ratón, 23 Ene 1959 (fl), *Romero-Castañeda 7055* (COL).

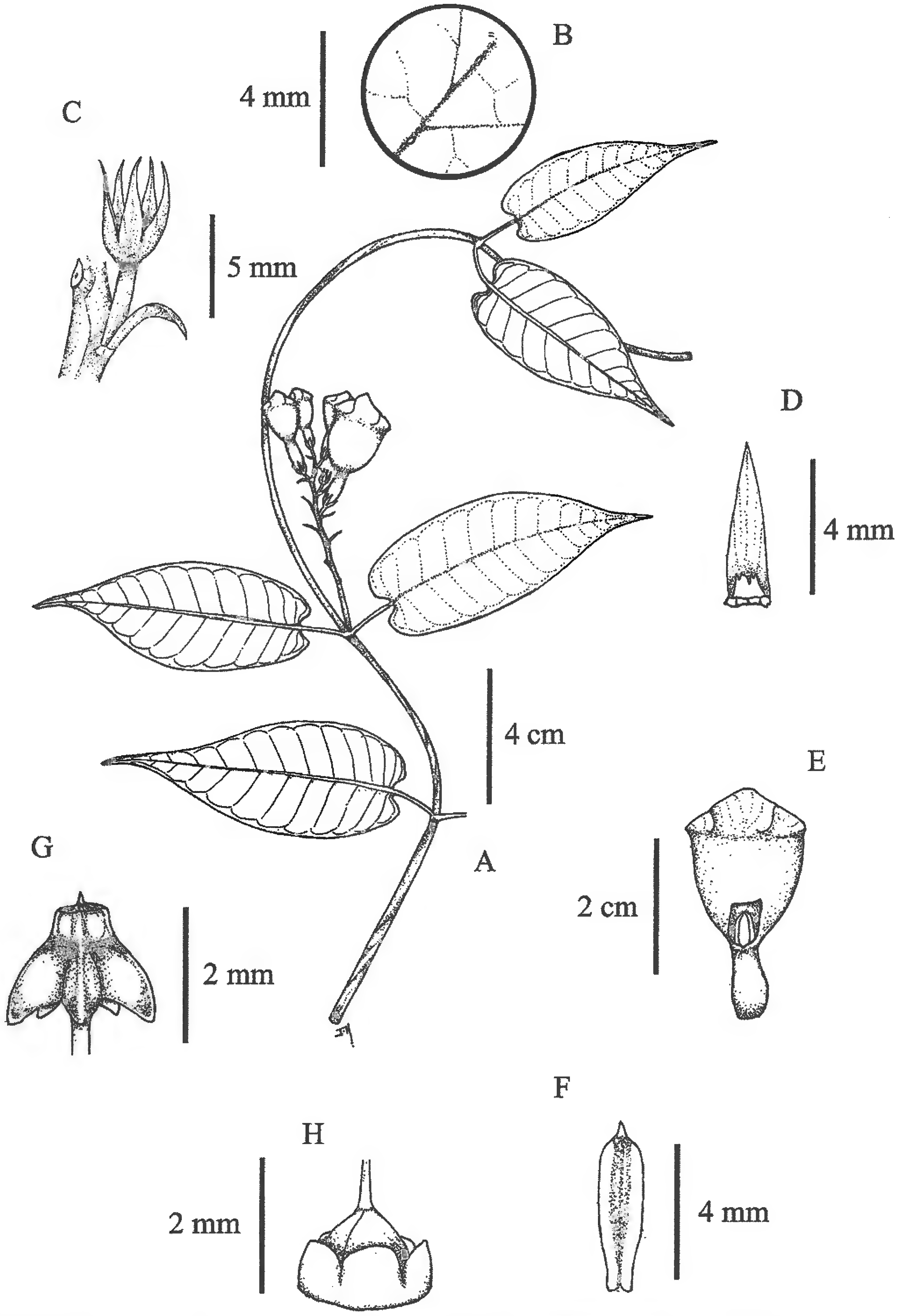


Fig. 3. *Mandevilla sanctae-martae* (*Kirkbride 2049*, INB). A. Ramita con inflorescencia. B. Detalle de la superficie adaxial de la hoja, mostrando los coléteres a lo largo del nervio central. C. Cáliz, pedicelo y bráctea. D. Vista adaxial de un sépalo, mostrando el coléter en la base. E. Botón floral parcialmente abierto, mostrando la posición de las anteras y el tubo basalmente giboso. F. Antera, vista dorsal. G. Cabeza estigmática. H. Nectario y ovario.

AGRADECIMIENTOS

Quiero agradecer a Julio Betancur y Rodrigo Bernal (COL) por las atenciones brindadas en las visitas al Herbario Nacional de Colombia (COL), así como a Ricardo Callejas, Francisco Roldán y Ramiro Fonnegra del herbario de la Universidad de Antioquia, Colombia (HUA) y a Eliana Noguera, Shingo Nozawa y Sirli Leython en el Herbario Nacional de Venezuela (VEN). Se agradece a los siguientes herbarios por el envio de material en préstamo o por el préstamo de sus colecciones: BM, C, CGE, COAH, COL, F, G, G-DC, HUA, K, M, MA, MO, NY, P, P-JU, P-LA, US. Thanks to Raul Gutierrez and Mary E. Endress for reviewing an earlier draft of the manuscript.

REFERENCIAS

Monachino, J. 1961. Apocynaceae. En, B. Maguire, J. Wurdack y colaboradores, eds. The botany of the Guayana Highland IV(2). Mem. New York Bot. Gard. 10(4):59–65.

Morales, J.F. 2005. Estudios en las Apocynaceae Neotropicales XIX: la familia Apocynaceae (Apocynoideae, Rauvolfioideae) en Costa Rica. Darwiniana 43:90–191.

Woodson, R.E. 1933. Studies in the Apocynaceae IV. The American genera of Echitoideae XXVI. Ann. Missouri Bot. Gard. 20:605–790.

BOOK REVIEW

JERRY A. POWELL AND PAUL A.OPLER. 2009. **Moths of Western North America.** (ISBN 978-0-520-25197-7, hbk.). University of California Press, 2120 Berkeley Way, Berkeley, California 94704-1012, U.S.A. (**Orders:** www.ucpress.edu or California-Princeton Fulfillment Services, 1445 Lower Ferry Road, Ewing, New Jersey 08618, U.S.A., orders@cpfsinc.com, 1-800-777-4726). $95.00, 369 pp., 66 color plates, 316 illustrations, 9" × 11 3/8".

This work, much needed, long anticipated, is an important contribution to the Lepidoptera literature of North America. It is a reference book on the families of moths; it is a field guide for collectors of specimens, photographs, or observations; and it is a readable text with the latest in research and in systematics. There is no comparable work.

The authors set out with definite goals in their coverage: morphology, larval biology, geographical distribution, and the treatment of at least 25% of the species in each family. Every superfamily, subfamily, and family is described as to basic characteristics, followed by species descriptions with reference to the 58 plates of photos of mounted specimens, some plates with more than 50 images. Plates 59 through 64 cover life cycles of selected microlepidoptera and the larvae of some "macros" photographed on their food plants. Western species predominate in coverage, but the West extends over the Rockies and into the Dakotas, Kansas, Texas, etc., and there are many moths known across the continent.

Botanists and horticulturists everywhere should find useful the Plant Index, in itself a formidable undertaking on the part of the authors, and very important as the plants in a way define the insect species. They will find it helpful to know which larvae have deleterious effects on the plants and find other items of interest such as which moths actually produce galls on plants.

The reputation of these two authors is uncontested, both having accomplished much in research and publication. One can be sure that their work is accurate in every detail and that they have incorporated in their conclusions the latest findings on every subject.—*Joann Karges, Texas Christian University Library (retired), Fort Worth, Texas, U.S.A.*

J. Bot. Res. Inst. Texas 3(2): 572. 2009

STUDIES OF NEOTROPICAL COMPOSITAE–II. A NEW COMBINATION IN *CHROMOLAENA* (EUPATORIEAE)

John F. Pruski

Missouri Botanical Garden
P.O. Box 299
St. Louis, Missouri 63166-0299, U.S.A.

ABSTRACT

The new combination **Chromolaena clematitis** is made for a South American species.

RESUMEN

Se presenta la nueva combinación de **Chromolaena clematitis** para una especie Sudamericana.

Most species of *Chromolaena* DC. (Compositae: Eupatorieae: Praxelinae) have been treated historically as members of *Eupatorium* sect. *Cylindrocephala* (e.g., Robinson 1918, 1919). *Chromolaena*, as summarized by King and Robinson (1987), however, differs from *Eupatorium* L. by glabrous (vs. setulose) style bases, distinct (vs. indistinct) carpopodia, and cylindrical involucres of deciduous (vs. persistent) phyllaries. *Chromolaena* differs from remaining genera of Praxelinae by subequal corolla lobes, receptacles that are usually flat on top, long pappus bristles, and style branches that are cylindrical and never clavate (King & Robinson 1987).

In a revision of Peruvian Eupatoriums, B.L. Robinson (1919) recognized the distinctive *Eupatorium clematitis* DC. (see Fig. 1), whereas King and Robinson (1987) and Robinson and Holmes (2008) list it in synonymy of *C. odorata* (L.) R.M. King & H. Rob. *Eupatorium clematitis* was not listed as occurring in Ecuador by Robinson (1918). *Chromolaena odorata* is common and widespread throughout much of the neotropics, and is known also as an introduced weed in the paleotropics (King & Robinson 1987; Pruski 1997). My treatment of Compositae for the Río Cenepa region of northern Peru recognizes *C. clematitis* as endemic to Ecuador and Peru, where it occurs in low foothills of the eastern Andes. The purposes of this paper are to provide a new combination for this species and a description of it for use as an aid in identifications.

Chromolaena clematitis (DC.) Pruski, comb. nov. (**Fig. 2**). Basionym: *Eupatorium clematitis* DC., Prodr. 5:144. 1836. *Osmia clematitis* (DC.) Sch. Bip., Jahresber. Pollichia 22–24:252. 1866. Type: "Peruvia?," 1834 [sic], *Poeppig 3108* (holotype: G-DC [photograph sub F neg. 8150 in MO, US; IDC microfiche 800. 803.III.6]; isotypes: F, W).

Perennial herbs to vining shrubs, 0.7–2 m tall; stems few-branched distally, subterete, puberulent to glabrate. Leaves simple, opposite, long-petiolate; petiole 0.8–3 cm long, slender, puberulent; blade deltate to hastate, 2–7 cm long, 0.6–5.5 cm wide, chartaceous to thinly so, 3-veined from base, base hastate to truncate, margins entire to few-serrulate, apex long-acuminate to attenuate, adaxial surface puberulent along veins to glabrous, abaxial surface densely red-glandular, otherwise puberulent to glabrous, the non-glandular trichomes very short. Capitulescence terminal, open, thyrsoid-paniculate with ultimate branches umbelliform to corymbiform, 2–21-headed, to 15–20 cm tall, ca. 15 cm wide. Capitula discoid, 23–26-flowered, 9.5–12.5 mm high, 2.8–3.5 mm wide; involucre cylindrical, 9–11.5 mm long, corollas slightly exserted; phyllaries imbricate, graduated, 5–7-seriate, tightly appressed, deciduous in fruit, scarious with apex subherbaceous, generally 3-nerved, most or at least the mid-series phyllaries truncate-mucronate apically, glabrous to outer series sparsely puberulent distally, outer ones elliptic-lanceolate to ovate, 1–2 mm long, 1–2 mm wide, grading into inner ones, these lanceolate, 9–11.5 mm long, 1–1.5 mm wide; receptacle epaleate, shortly clavate but flat on top, ca. 1.6 mm tall and wide, glabrous; peduncle 1–2.5 cm long, striate, often 1- or 2-bracteolate, puberulent, main capitulescence stalk to 6 cm long. Florets bisexual; corolla white, funnelform, 4.8–5.7 mm long, glabrous, lobes subequal, ca. 0.5 mm long, erect to slightly spreading; anthers included; style

J. Bot. Res. Inst. Texas 3(2): 573 – 576. 2009

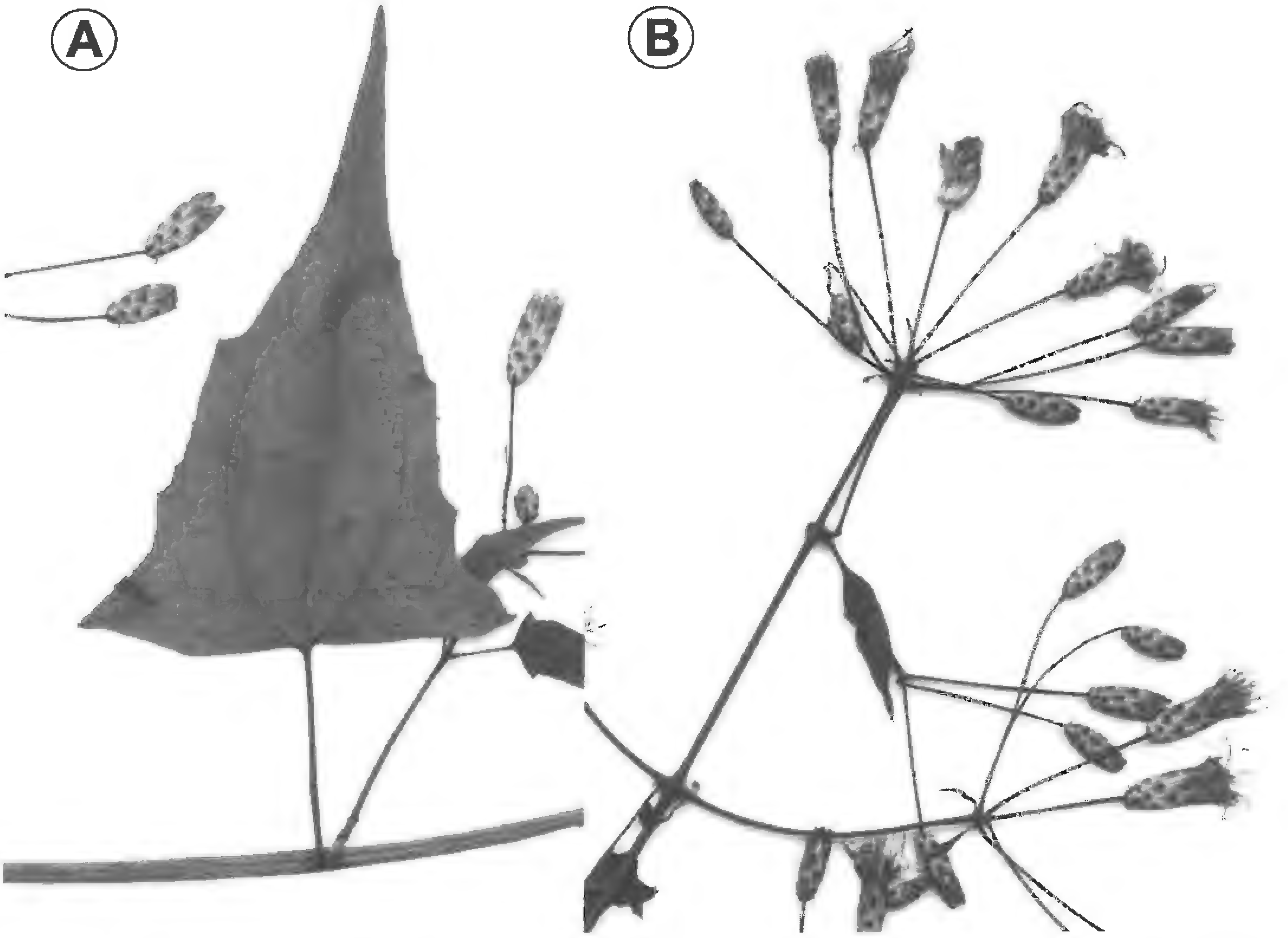


Fig. 1. *Chromolaena clematitis* (DC.) Pruski. A. Leaf showing hastate base (*Palacios 12395*, MO). B. Capitulescence showing ultimate branches umbelliform with long-pedunculate capitula. (*Rueda et al. 1043*, MO).

base glabrous, branches cylindrical, greatly exserted from corolla, 3–4 mm long, the proximal half of each branch with paired ventro-marginal stigmatic lines, the distal half with minutely papillose sterile appendage with an acute to obtuse apex. Cypselae narrowly obconical, brown with tan angles, 3–3.6 mm long, 3–4-angled, glabrous; carpopodium distinct, tan, circular; pappus bristles many, elongate, stramineous, ca. 5.5 mm long.

Additional specimens examined: **ECUADOR. Napo:** Estación Biológica Jatun Sacha, Río Napo, 8 km al E de Misahuallí, bosque muy húmedo tropical, potrero a 200 m al sur de la reserva, 1°04'S, 77°36'W, 450 m, 23–27 Jun 1987, *Cerón 1678* (MO); Tena Cantón, Aliahui, bosque húmedo tropical, area degradada en viejo pastizal, 450 m, 1°04'S, 77°36'W, Jul 1994, *Palacios 12395* (MO); Tena Cantón, Estación Biológica Jatun Sacha, sendero 1 y 3, 1°04'S, 77°36'W, 380 m, 9 Aug 1992, *Rueda et al. 1043* (MO). **PERU. Amazonas:** Bagua Prov., Yamayakat, bosque secundario, 4°55'S, 78°19'W, 350 m, 10 Jun 1995, *Vasquez et al. 20117* (MO). **San Martín:** Mariscal Caceres, Tocache Nuevo, Puerto Pizana, márgen derecha del río Huallaga, 350–400 m, 22 Jun 1974, *Schunke V. 6995* (MO).

Distribution and ecology.—*Chromolaena clematitis* is known to flower from June to August at elevations between 350–450 meters in the eastern Andean foothills of Ecuador and Peru from about 1–8° south latitude.

Chromolaena clematitis is known only from a few collections in northern Peru and eastern Ecuador, from where the type was presumably collected. By *gestalt* and reddish sessile glands of the abaxial leaf surfaces, *C. clematitis* is similar to *C. odorata*, under which it was synonymized by King and Robinson (1987) and Robinson and Holmes (2008). *Chromolaena clematitis* is recognized easily, however, by its leaves with hastate to truncate bases and capitulescences with ultimate branches of long-pedunculate typically umbelliform capitula. Although across its broad range in both hemispheres *C. odorata* is somewhat variable in shape and pubescence of leaves and phyllaries, its variation is minor and continuous, while *C. clematitis* remains

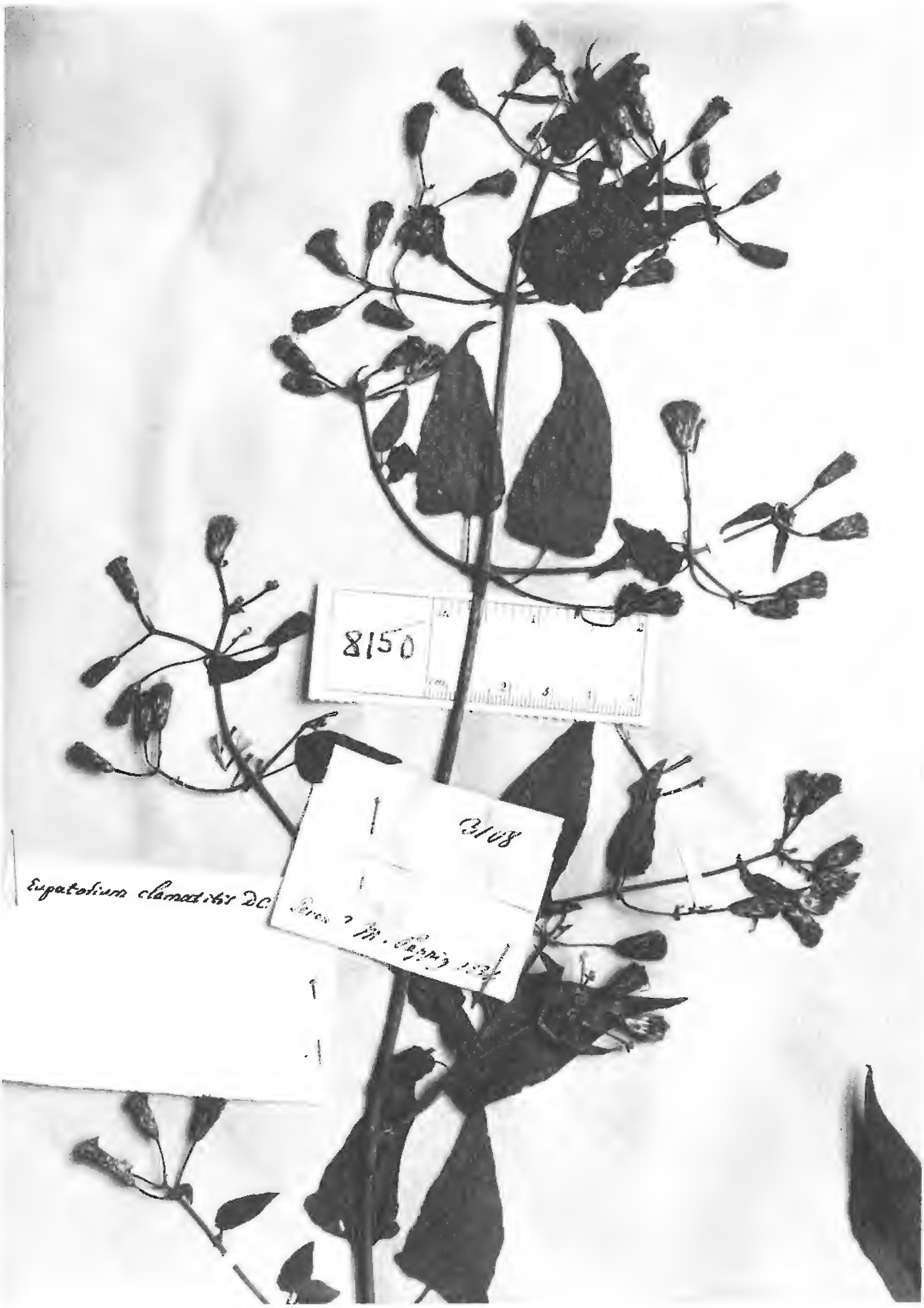

8150
3108
Eupatorium clematitis DC.

Fig. 2. Photograph of the holotype (*Poeppig 3108*, G-DC) of *Eupatorium clematitis* DC.

consistently distinctive. *Chromolaena clematitis* differs from *C. odorata* by basally hastate to truncate (vs. attenuate to subtruncate) leaves with blades glandular, otherwise puberulent to glabrous (vs. glandular and pubescent) abaxially, by ultimate branches of the capitulescences with long (vs. short)-pedunculate typically umbelliform (vs. corymbiform) capitula, and by most or at least the mid-series phyllaries with truncate-mucronate (vs. acute to rounded) apices.

ACKNOWLEDGMENTS

I would like to thank Rosa Ortiz (MO) for translating the abstract into Spanish and for helping prepare Figure 1, Walter Holmes (BAYLU), Rosa Ortiz (MO), and Harold Robinson (US) for comments on the manuscript, Lucia Kawasaki and Anna Balla (F) for sending me an image of the holotype, and Christine Niezgoda (F) for permission to publish this photograph.

REFERENCES

King, R.M. and H. Robinson. (1987). The genera of Eupatorieae (Asteraceae). Monogr. Syst. Bot. Missouri Bot. Gard. 22:1–581.

Pruski, J.F. 1997. Asteraceae. In: J.A. Steyermark, P.E. Berry, and B.K. Holst, eds. Flora of the Venezuelan Guayana, vol. 3. Missouri Botanical Garden, St. Louis. Pp. 177–393.

Robinson, B.L. 1918. Keyed recensions of the Eupatoriums of Venezuela and Ecuador. Proc. Amer. Acad. Arts 54:331–367.

Robinson, B.L. 1919. A recension of the Eupatoriums of Peru. Proc. Amer. Acad. Arts 55:42–88.

Robinson, H. and W.C. Holmes. 2008. 190(3). Compositae-Eupatorieae. Flora of Ecuador 83:1–347.

FOLIA TAXONOMICA 13. *PASSIFLORA CURVA* (PASSIFLORACEAE), A NEW SPECIES FROM FRENCH GUIANA IN SUBGENUS *PASSIFLORA* SUPERSECTION *COCCINEA*

Christian Feuillet

Department of Botany, MRC-166
Smithsonian Institution
P.O. Box 37012
Washington, DC 20013-7012, U.S.A.
feuillec@si.edu

ABSTRACT

A new species, **Passiflora curva,** is described in subgenus *Passiflora* supersection *Coccinea*. It was collected in French Guiana, in the lower Sinnamary River basin. *Passiflora curva* is easily set apart from the other species of the supersection by its leaves with margins crenate toward the base and serrate toward the apex, its bracts less than 3 cm long and its flowers with a straw-colored tube, and the outer corona filaments white and erect.

RÉSUMÉ

Une espèce nouvelle, **Passiflora curva,** est décrite du sous-genre *Passiflora* supersection *Coccinea*. Elle a été récoltée en Guyane, dans le bassin de la basse Sinnamary. *Passiflora curva* est facile à séparer des autres espèces de la supersection par ses feuilles à marge crénée vers la base et serrée vers l'apex, ses bractées longues de moins de 3 cm, ses fleurs avec un tube beige et le verticille extérieur de la couronne blanc et érigé.

During a field trip in French Guiana in September 2008, I had the opportunity to visit the type locality of *Passiflora aimae* Annonay & Feuillet (1998) and collected two good specimens of another species that clearly belong also in *Passiflora* supersect. *Coccinea* Feuillet & J.M. MacDougal. The new species, *P. curva,* and *P. aimae* differ in several details. Most interesting characters of the new species are the straw color of the bud and floral tube, and the morphology of the two-row corona in which the outer row of filaments is erect, leaning neither inward nor outward. Pictures of both species have been published; *Passiflora aimae* in Ulmer & MacDougal (2004: pl. 161, p. 212; photo H. Annonay); and *Passiflora curva* (as *P. aimae*) in Ulmer & MacDougal (2004: pl. 8, p. 165; photo H. Gelewsky) and in Ulmer & Ulmer (2005: p. 9; photo H. Gelewsky). Some have been uploaded and are available on the web: *Passiflora aimae* on C. Houel's website (photo C. Houel); and *Passiflora curva* on C. Houel's web site (as "sp. Distephana"; photo C. Houel); and on Flickr in cpf1's photostream (as *P. curva*; photo C. Feuillet). Christian Houel ("Collection Nationale de Passiflores", France) became aware there were two different species when he found the two growing side by side. As far as I know, encounters with this species by various persons previous to the type collection were not documented by herbarium specimens, but it may be in cultivation in Europe or in Martinique where H. Annonay has his collection.

Passiflora curva Feuillet, sp. nov. (**Fig. 1**) Type: FRENCH GUIANA: lower Sinnamary River basin, ca. 20 km SW of Sinnamary, on the roadside of Route de St Élie (D 21), 13 km S of the road from Cayenne to St.-Laurent-du-Maroni (N 1), 5°18'20"N 53°02'21"W, 35 m, 28 Sep 2008, fl., *Feuillet 17049* (holotype: US; isotypes: BRIT, CAY).

Passiflora curva in subg. *Passiflora* supersect. *Coccinea* pertinens; inter species hujus supersectionis foliis margine laxe leviterque crenatis (ab basi ad circa medium) vel serratis (ab circa medio ad apicem), bracteis minus 3 cm longis, hypanthio extus stramineo differt.

Climber with tendrils; plant with short trichomes on vegetative parts, the outide of the sepals, the androgynophore, and the gynoecium, the flower otherwise glabrous. Stem reddish, somewhat 5-angular, reaching at least 6 m long. Tendrils axillary, reddish. Stipules setaceous, reddish, 5–6 mm long. Leaves alternate petiole 1–1.8 cm long, reddish, with a pair of glands at the base, glands round and plump, green when young becoming reddish; blade ovate, 7–12 × 3.5–7 cm, base truncate to slightly cordate and shortly cune-

J. Bot. Res. Inst. Texas 3(2): 577 – 580. 2009

ate, apex rounded to slightly acute, short acuminate, margin reddish-brown, slightly and loosely crenate in basal third and serrate in apical two thirds, adaxial surface yellowish-green when young becoming dark green, abaxially pale grey becoming light green, veins reddish, 5–6 veins each side of the midrib. Peduncle axillary, solitary, erect, 4–5 cm long, reddish; bracts (1 bract & 2 bracteoles) verticillate, inserted 1 mm below the joint, similar in shape and size, 1.5–2.2 × 0.6–0.8 cm, red, green at base, 4–5 pairs of glands at margin, glands round, green, larger at base; above the joint, floral stipe 0.4–0.5 cm long. Flowers erect floral tube campanulate, base invaginate around the apex of the stipe, forming inside a 10-lobed nectar chamber at the bottom, 10–12 cm long, greenish straw-colored suffused with pink and with 10 green veins outside, inside pink to red; sepals red but the parts exposed in the bud straw-colored abaxially, narrow oblong, carinate, with a 2–4 mm long subterminal red awn curved inward, round at apex, 3 × 0.6 cm; petals red all over, without carina or awn, otherwise similar to sepals; corona in 2 rows, the outer row of white erect filaments about 1 cm long, laterally flattened, subulate, apex reaching the level of the base of the stamens, but not leaning on the androgynophore, inner row about as long, membranous in the basal half, oblique toward the androgynophore, white suffused with pink, and filamentous in the apical half, white, pointing toward the base of the tube and leaning on the androgynophore, then becoming straight and erect; operculum born 2/3 up the tube, membranous, parallel to the inner corona, bent about 2/3 from the base, short fimbriate at margin, white suffused with pink; nectary ring on the bottom of the tube reddish; limen pinkish, membranous, toothed at margin, surrounding the base of the androgynophore, curved outward at margin; androgynophore 2.5 cm long, white at base, cream dotted with red above; stamens 5, shortly fused at base, hiding the short gynophore and the base of the ovary, filaments dorsiventrally flattened, 15 × 1.5 mm, cream heavily spotted with red, emarginate at apex, anthers 9 × 2.5 mm, nearly rectangular, dorsifixed, held transversly, white, slightly greenish-cream near margin, pollen white; ovary ovoid, 9 × 2 mm, cream, styles slightly S-shaped, 6–7 mm long, diameter slightly increasing toward the apex, stigmas globular, 1.5–2 mm in diam., stigmatic surface cream, otherwise bright red. Fruits not seen; (the following from a photograph by C. Houel) unripe fruit green, dotted with white, ovoid.

By its red bracts with marginal glands, red-faced flowers, white erect straight outer corona filaments, and leaves crenate to serrate and glandular at margin, *P. curva* belongs in subg. *Passiflora* supersect. *Coccinea*. It differs from the other species by the combination of the following characters: the leaf blade margins are loosely and slightly serrate in the apical half and loosely and slightly crenate in the basal half, the bracts are much shorter than the flowers, the floral tube and the parts of the calyx exposed in the bud are straw-colored, and the corona has 2 rows, the outer row erect and comprised of white filaments not leaning on the androgynophore. Lastly, the inner corona row partly membranous, initially held horizontally (unpublished photograph) and later upward oblique. In both stages it is bent in the middle with the apical filamentous half held downward oblique, (Fig. 1, both photographs taken around 8:00 am, 28 Sep 2008). Ultimately it unfolds to become erect and parallel to the outer row (unpublished drawing of the paratype by J. Vanderplank, around 10:30 am, 17 Mar 2009). The basal membrane of inner row of the corona is an effective, although temporary, barrier keeping pollinators or nectar robbers away from the second obstacle, the operculum, on the way to the nectar. The flowers of the type collection had the inner row of the corona bent when split open and placed in the loosely tied field press, but the filaments straightened before being placed in the drier.

In the last published key of the supersection (Feuillet 2007), *P. curva* would be in a new third arm of bracket 4, reading: “Leaf margin slightly crenate in basal third and slightly serrate in distal two third,” as opposed to “Leaf margin crenate” or “Leaf margin dentate or serrate.” The second group includes 9 species with largely or densely serrate or biserrate leaf margins. The first group includes 2 species with crenate leaf margins from the same small area of forested hills west of the Lower Sinnamary River, *P. aimae* with a much shorter corona, 0.5–0.6 mm versus1 cm, whose inner row is red, and *P. longicuspis* Vanderpl. with a much longer corona, 1.8–2.4 cm, in 3 rows whose 2 outside rows are red or deep purple, and both with the corona filaments leaning on the androgynophore.

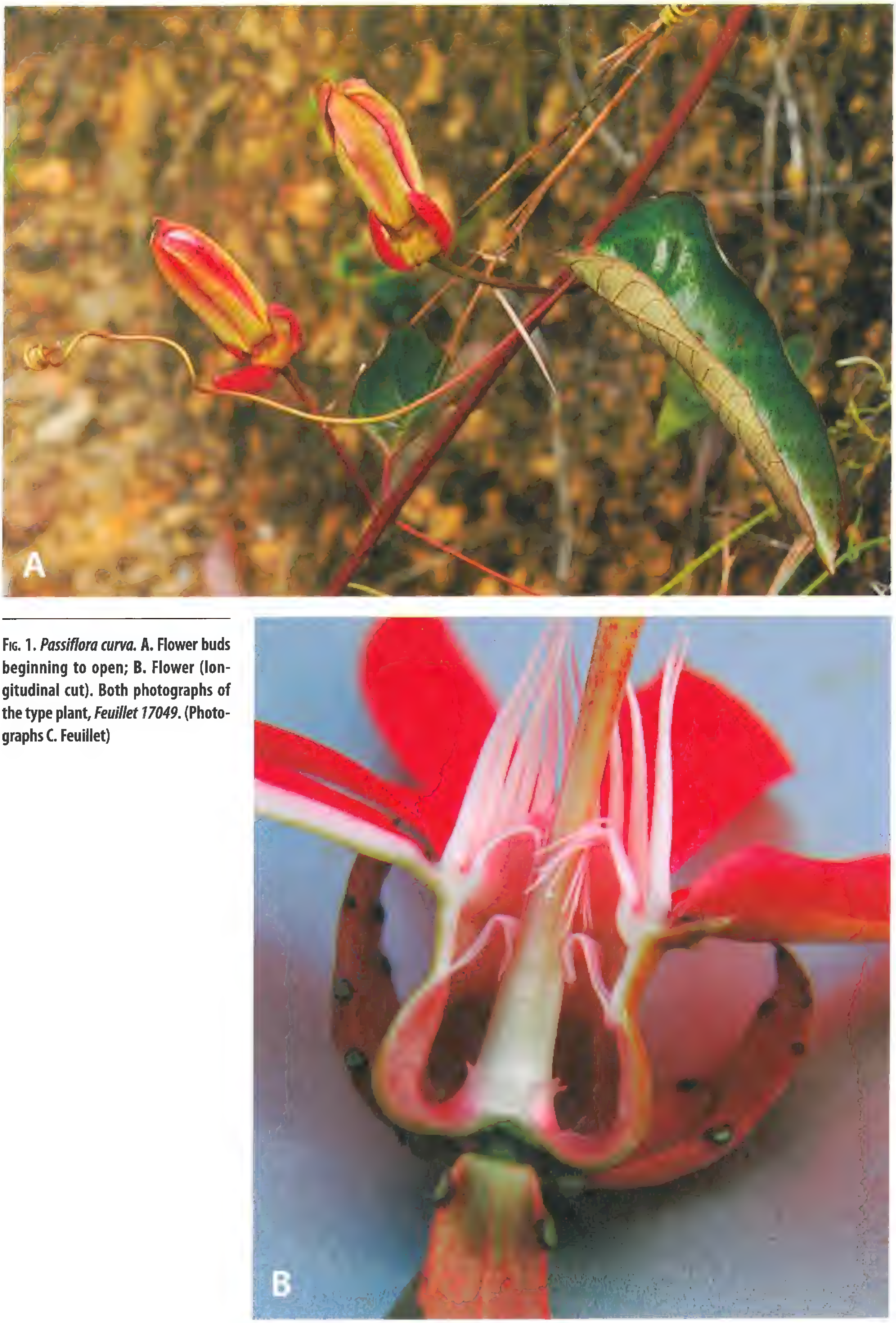


Fig. 1. *Passiflora curva*. A. Flower buds beginning to open; B. Flower (longitudinal cut). Both photographs of the type plant, *Feuillet 17049*. (Photographs C. Feuillet)

Distribution and phenology.—*Passiflora curva* is known only from the type locality west of the Sinnamary River, 13 km south of Road N 1, on the first hills south of the littoral savannas. It was found blooming in March and September.

Etymology.—The epithet, from the Latin adjective *curvus*, means bent, referring to the morphology of the inner row of the corona at early anthesis.

PARATYPE: **FRENCH GUIANA:** ca. 20 km SW of Sinnamary, on the roadside of Piste de St Élie, 13 km from Rd 1, 5° 18'20"N 53° 02'21"W, 35 m, 17 Mar 2009, fl., *R.J.R. Vanderplank, C. Feuillet & M. Vecchia 1620/09* (CAY, Nat Coll. Passiflora UK).

ACKNOWLEDGMENTS

I thank John MacDougal and Steve Tillett for their review of the manuscript. I am indebted to Christian Houel and John Vanderplank for sharing their data. I thank Sophie Gonzalez, director of the herbarium in Cayenne (CAY) for providing the ideal conditions to work with the collections in her care. This is number 154 in the Smithsonian's Biological Diversity of the Guiana Shield Program publication series.

REFERENCES

ANNONAY, H. AND C. FEUILLET. 1998. *Passiflora aimae* (Passifloraceae), une espèce nouvelle de Guyane française. Adansonia sér. 3, 20:295–298.

FEUILLET, C. 2007. Folia taxonomica 2. New species of *Passiflora* subgenus *Passiflora* (Passifloraceae) from the Guianas. J. Bot. Res. Inst. Texas 1:819–825.

FEUILLET, C. in Flickr website, flickr.com/photos/68587888@N00/3219887235/, accessed 20 June 2009.

HOUEL, C. website http://www.passiflorae.fr/, accessed 5 April 2009

ULMER, B. AND T. ULMER. 2005. Farbatlas passionsblumen. Formosa Verlag, Witten.

ULMER, T. AND J.M. MACDOUGAL. 2004. *Passiflora*, passionflowers of the world. Timber Press, Portland, Oregon.

FOLIA TAXONOMICA 14. NOTES ON *PASSIFLORA* SUPERSECTION *COCCINEA* (PASSIFLORACEAE) FROM THE GUIANA SHIELD

Christian Feuillet
Department of Botany, MRC-166
Smithsonian Institution
P.O. Box 37012
Washington, DC 20013-7012, U.S.A.
feuillec@si.edu

John Vanderplank
National Collection of Passiflora
Lampley Road, Kingston Seymour
Clevedon, North Somerset BS21 6XS, U.K.
johnvanderplank@yahoo.co.uk

ABSTRACT

New collections and expanded distributions are given for three species of *Passiflora* supersect. *Coccinea* from the Guiana Shield, *P. compar, P. longicuspis* and *P. tecta*.

RÉSUMÉ

Des collections nouvelles étentent la répartition de trois espèces de *Passiflora* supersect. *Coccinea* du Bouclier Guyanais, *P. compar, P. longicuspis*, et *P. tecta*.

During a field trip in French Guiana in March 2009, we had the opportunity to study the collections at CAY. Some interesting specimens of *Passiflora* species belonging in subg. *Passiflora* supersect. *Coccinea* Feuillet & J.M. MacDougal are worth mentioning as they represent recently described and poorly collected species (Vanderplank 2006; Feuillet 2007, 2008). This triggered a reexamination of the specimens representing species of supersect. *Coccinea* with unlobed leaves at US and in the herbarium associated with the greenhouses holding the National Collection of *Passiflora* (United Kingdom). The new data presented here expand the known distribution area for those species.

1. **Passiflora compar** Feuillet, J. Bot. Res. Inst. Texas 1:821. 2007.

Passiflora compar is easily separated from other species of supersection *Coccinea* by its leaves that are much thinner and from most other species by the corona with 2 rows of red or pink filaments 5–7 mm long.

Additional collection: **FRENCH GUIANA:** near the Arataye River, Montagne des Nouragues, around camp, edge of helicopter pad, 200 m, 6 Jan 2003, fl., *S.A. Mori et al. 25527* (CAY, NY); Saül, vicinity of Eaux Claires, 3°37'N, 53°12'W, ca. 300 m, 16 Feb 1993, fl., *S.A. Mori et al. 23004* (NY, US).

Distribution and phenology.—*Passiflora compar* is known in Guyana from the Upper Takutu-Upper Essequibo Region, Kanuku Mts., from the Potaro–Siparuni Region, near Kato, and in French Guiana from the upper Maroni basin, Saut Lavaud, from the Saül area, Eaux Claires, and from Montagne des Nouragues. It inhabits moist forest below 400 m of elevation, near rivers or on slopes. It is expected to be present in Surinam. *Passiflora compar* was blooming in January, February, March, September, and November; it was fruiting in February and March.

2. **Passiflora longicuspis** Vanderplank, Curtis's Bot. Mag. 23:232; pl. 563. 2006.

Passiflora longicuspis is characterized by the corona filaments, 22–26 mm long, reaching the ovary on top of the androgynophore. It is also one of the few with crenate leaf margins, one of the few with small bracts, and one of the few with colored outer corona filaments.

Additional collection: **FRENCH GUIANA:** Cayenne, Mont Baduel, 10 m, 2 Jun 1987, fl., *M. Hoff 5222* (CAY); Piste de St. Élie, Mar 2003, fl., *R.J.R. Vanderplank & S.E. Vanderplank 1762/09* (National Collection of *Passiflora* herbarium).

Distribution and phenology.—The type of *P. longicuspis* from the British National Collection of *Passiflora* originated in French Guiana from Route de St Élie, near the Sinnamary River. The new collections are from Mont

J. Bot. Res. Inst. Texas 3(2): 581 – 582. 2009

Baduel situated inside the administrative limits of the city of Cayenne and from the hills SW of Sinnamary neat the type locality. It was blooming in March and June.

3. Passiflora tecta Feuillet, J. Bot. Res. Inst. Texas 2:281. 2008.

In the supersection, *P. tecta* is characterized by its leaf blades that are bi-serrate with the serrations tipped with glands, its corona in 3 rows of filaments, and the 2 outer rows that are deep red with the outmost row 12 mm long and the middle row 9 mm long.

Additional collections: **VENEZUELA. Bolívar:** Roscio Distr., between San Francisco de Yuruaní and Chirimatá, 5°02'N 61°00'W, 1100 m, 2 Mar 1984, fl., *O. Huber 9154* (US). **GUYANA. Cuyuni – Mazaruni:** Ayanganna Plateau, 740 m, 19 Jul 1960, fl., *S.S. Tillett et al. 44873* (NY, US); Groete Creek, Lower Essequibo River, 26 Jun 1944, fl., *D.B. Fanshawe 4728 (F1992)* (NY, US); Ridge of Eagle Mountain, 5°12'N 59°07'W, 304–685 m, 10 Oct 1990, fr., *T. McDowell 3472* (US). **Essequibo Isl. – W Demerara:** Lower Tiger Creek, 6°30'N 58°39'W, 0–15 m, 12 Dec 1992, fl., *T.W. Henkel 485* (US). **Potaro – Siparuni:** Essequibo River, Karupukari Crossing, 4°40'N, 58°41'W, 60–75 m, 19 Apr 1992, fl. & fr., *B. Hoffman 1345* (US); Iwokrama Rainforest Reserve; N of Surama, 4°10'N, 59°3'W, 200 m, 20 May 1995, fl., *C. Ehringhaus 89* (CAY, US). **Upper Demerara – Berbice:** 16–22 km from Ituni along Ituni - Kwakwani Road, 5°254N, 58°10'W, 70 m, 19 Jan 1990, fl., *L.J. Gillespie et al. 3086* (CAY, US). **SURINAM. Sipaliwini:** vicinity of Blanche Marie Waterfall, 4°45'20"N 56°54'19"W, 60 m, 3 Feb 1998, fl., *J.S. Miller et al. 9304* (MO, US)

Two more specimens from plants having a pale band on the outer corona row probably represent the same species.

SURINAM. Brokopondo: Brownsberg, 1997, fl., *NCP 1086/06* (National Collection of *Passiflora* herbarium). **UNITED KINGDOM:** cultivated from seed collected in Surinam, National Collection of *Passiflora* greenhouses, 2000, *NCP 1302/08* (National Collection of *Passiflora* herbarium).

Distribution and phenology.—Passiflora tecta is now known from the State of Bolívar in Venezuela, from Guyana, and from northern Sipaliwini and perhaps Brokopondo in Surinam. It was blooming in January, February (photograph only), April to July, and September; it was in fruit in February (photograph only), April, and October.

ACKNOWLEDGMENTS

We are grateful to John MacDougal and Steve Tillett for reviewing the manuscript. We thank Sophie Gonzalez, director of the herbarium in Cayenne (CAY) for providing the ideal conditions to work with the collections in her care. This is number 155 in the Smithsonian's Biological Diversity of the Guiana Shield Program publication series.

REFERENCES

Feuillet, C. 2007. Folia taxonomica 2. New species of *Passiflora* subgenus *Passiflora* (Passifloraceae) from the Guianas. J. Bot. Res. Inst. Texas 1:819–825.

Feuillet, C. 2008. Folia taxonomica 8. *Passiflora tecta,* a new species in subgenus *Passiflora* from the Guianas. J. Bot. Res. Inst. Texas 2:281–283.

Vanderplank, J. 2006. Plate 563. *Passiflora longicuspis* (Passifloraceae). Curtis's Bot. Mag. 23:231–236; plate.

FOLIA TAXONOMICA 15. FIVE NEW SPECIES OF *PARADRYMONIA* SUBGENUS *PARADRYMONIA* (GESNERIACEAE: EPISCIEAE) FROM THE VENEZUELAN GUAYANA

Christian Feuillet

Department of Botany, MRC-166
Smithsonian Institution, P.O. Box 37012
Washington, DC 20013-7012, U.S.A.
feuillec@si.edu

ABSTRACT

Five species of *Paradrymonia* subg. *Paradrymonia* (Gesneriaceae: Episcieae) are described from the state of Amazonas, Venezuela: **Paradrymonia glandulosa, P. hamata, P. lutea, P. tepui,** and **P. yatua.**

RÉSUMÉ

Cinq espèces de *Paradrymonia* subg. *Paradrymonia* (Gesneriaceae : Episcieae) sont décrites de l'état d'Amazonas, Venezuela: **Paradrymonia glandulosa, P. hamata, P. lutea, P. tepui** et **P. yatua.**

RESUMEN

Cinco especies de *Paradrymonia* subg. *Paradrymonia* (Gesneriaceae: Episcieae) son descritas del estado Amazonas, Venezuela: **Paradrymonia glandulosa, P. hamata, P. lutea, P. tepui** y **P. yatua.**

Continuing the publication of new species of *Paradrymonia* Hanst. from the Venezuelan Guayana (for an introduction cf. Feuillet 2009), I propose here five new species in subgenus *Paradrymonia*.

1. Paradrymonia glandulosa Feuillet, sp. nov. (**Fig. 1**). TYPE: VENEZUELA. AMAZONAS. Depto. Atabapo: Cerro Marahuaca, "Sima Camp", south-central portion of forested slopes along eastern branch of Caño Negro, 3°43'N, 65°31'W, 1140 m, 21–24 Feb 1985, fl., *J.A. Steyermark & B. Holst 130443* (HOLOTYPE: US; ISOTYPES: MO, VEN).

Paradrymoniae ciliosae affinis; lamina ovata vel late elliptica, sepalis apice linearibus, corolla 3.5 cm longa, corollae lobis brevis, non fimbriatis differt.

Terrestrial, saxicolous herb or basal trunk epiphyte. Stem sappy becoming subwoody at base, procumbent, hirsute, glabrescent towards base, about 0.5 cm thick. Leaves strongly unequal in a pair, the smaller one early deciduous; larger leaf: petiole 8–15 cm long, densely to slightly appressed-pilose; blade chartaceous when dry, 20–28 × 10–13 cm, broadly ovate to elliptic, base cuneate, apex acuminate to caudate, margin glandular serrate, above appressed-pilose to glabrous, beneath minutely pubescent to glabrous. Inflorescence axillary, fasciculate; pedicels 0.1–0.6 cm long, densely pilose, trichomes red. Flower: sepals pale green bordered with maroon, free, subulate, 8–20 × 1–1.5 mm, apex long linear-acuminate about half the total length, margin loosely glandular serrate, pilose; corolla creamy white with purple lines, oblique in the calyx, basal gibbosity prolonging the tube, curved, 3 × 2 mm, tube 2.5 cm long, narrow for 1.8 cm, then widely funnel-shaped, with red trichomes, lobes shallow. Fruits not seen.

Distribution.—Paradrymonia glandulosa was collected on forested slopes of Cerro Marhuaca and Cerro Yapacana, department of Atabapo, state of Amazonas (Venezuela), between 1140–1200 m. It was in bloom in January–February.

Paradrymonia glandulosa resembles *P. ciliosa* by its general appearance: thick stem with usually short internodes, creeping on rocks or climbing lower tree trunks, large leaves with long petioles, and very short inflorescences in the leaf axils. It differs from *P. ciliosa* and other species of subg. *Paradrymonia* from Venezuelan Guayana by the leaf blade ovate to widely elliptic with teeth wide-glandular at the tip, the sepals subulate and linear-acuminate, the corolla with a curved basal gibbosity, and short, non fimbriate lobes.

J. Bot. Res. Inst. Texas 3(2): 583 – 592. 2009

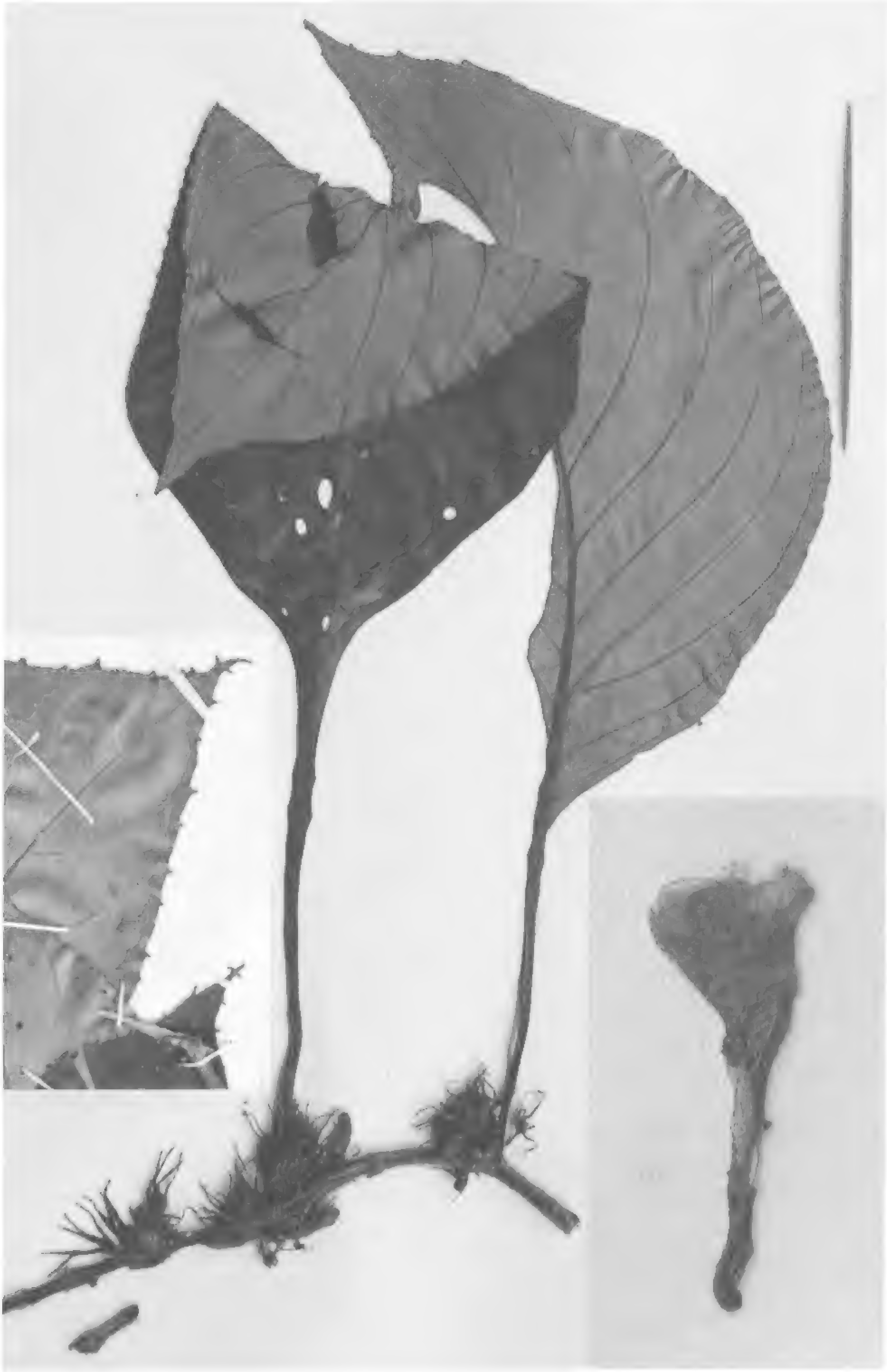


Fig. 1. *Paradrymonia glandulosa, Steyermark & Holst 130443* (isotype: MO), shorter distance between the 2 petioles = 6 cm; leaf margin inset, *idem* (US), length of the inset = 12 cm; corolla inset, *Maguire, Cowan & Wurdack 30657* (NY), total length of the object = 3.5 cm.

Although the flowers pressed in situ seem erect in the calyx, a separate corolla in the pocket of *Maguire et al. 30657* clearly shows a lateral insertion at the base between the curved gibbosity and the tube suggesting that the corolla is strongly oblique in the calyx and that the calyx is itself oblique on the pedicel. A situation possibly imposed by the multi-flowered fasciculate inflorescence developing between the stem and the long petioles. This species was "sp. C" in Feuillet & Steyermark (1999).

Etymology.—The epithet *glandulosa* refers to the glandular teeth on the margin of the leaf blades, the bracts, and the calyx lobes.

Paratype: **VENEZUELA. Amazonas. Depto. Atabapo:** Cerro Yapacana, on slopes and cumbre, 1200 m, 3 Jan 1951, fl., *B. Maguire, R.S. Cowan & J.J. Wurdack 30657* (NY).

2. Paradrymonia hamata Feuillet, sp. nov. (**Fig. 2**). Type: VENEZUELA. Amazonas. Depto. Río Negro: Cerro de la Neblina, Río Yatúa, 140–1700 m, 31 Dec 1957, fl., *B. Maguire, J.J. Wurdack & C.K. Maguire 42563* (holotype: NY).

Paradrymoniae ciliosae affinis; lamina ovata vel orbiculata, pedicello usque ad 4.5 cm longo, sepalis in dimidio superiore linearibus, corolla 5–6 cm longa differt.

Terrestrial (?) herb; stem about 0.5 cm thick; trichomes red. Leaves so unequal in a pair that they look alternate, small one obsolete or early deciduous, lamina not developing; larger one: petiole 5–12 cm long, pubescent; blade broadly ovate to orbicular, base rounded or obtuse, then abruptly cuneate and narrowly somewhat decurrent, apex broadly and shortly acuminate, margin obscurely to clearly glandular-serrate, above minutely puberulent to glabrous, beneath appressed-pubescent on mains veins, trichomes scattered between, margin densely appressed pubescent. Inflorescence axillary, fasciculate, pedicel 1–4.5 cm long, long-hirsute. Flowers: calyx with long, erect, trichomes, sepals narrowly triangular-elliptic and for half its length long linear-acuminate, 15–20 × 2–3 mm, with 1–3 teeth on the linear tip and near its base; corolla white or hyaline with scattered trichomes outside, basal gibbosity 0.4–0.5 × 0.4 mm, tube narrowly tubular at base, abruptly widening, then broadly tubular, 4–4.5 cm long, with white trichomes, lobes suborbicular, 0.9–1.2 cm, the ventral lobe shortly fimbriate, the others crenate to entire at margin; stamens borne near base of the tube, seen only recoiled to the base of the wide portion of the tube, anthers thecae widely divergent, about 1.5 mm long. Fruit not seen.

Distribution.—*Paradrymonia hamata* was collected partly buried in duff at 1200 m on Cerro de la Neblina (Department Río Negro) and Cerro Yapacana (Department Atabapo) in the state of Amazonas (Venezuela). It was in bloom in January and December.

Paradrymonia hamata resembles *P. ciliosa* by its general appearance: thick stem with usually short internodes, creeping on rocks or climbing lower tree trunks, large leaves with long petioles, and very short inflorescences in the leaf axils. It differs from *P. ciliosa* by the leaf blade ovate to orbicular, pedicels up to 4.5 cm long, versus up to 2.5 cm, the sepals linear-acuminate in the apical half, the corolla tube 4–4.5 cm long, versus 2–3 cm, and a much smaller basal gibbosity. *Paradrymonia hamata* can be separated from *P. lutea* by its white coralla versus yellow, from *P. tepui* and *P. yatua* by its calyx lobes partly linear acuminate versus elliptic, from *P. glandulosa* by its white corolla trichomes versus red, and from the other species of subg. *Paradrymonia* from Venezuelan Guayana by its leaves broadly ovate to orbicular versus oblanceolate to elliptic. This species was "sp. B" in Feuillet & Steyermark (1999).

Etymology.—The epithet *hamata* refers to the barb-like trichomes on the linear tip of the sepals.

Paratype: **VENEZUELA. Amazonas: Depto. Atabapo:** Cerro Yapacana, Río Orinoco, 1200 m, 2 Jan 1951, fl., *B. Maguire, R.S. Cowan & J.J. Wurdack 30621* (NY).

3. Paradrymonia lutea Feuillet, sp. nov. (**Fig. 3**). Type: VENEZUELA. Amazonas. Depto. Río Negro: Neblina Massif, Canyon Grande, along Río Mawarinuma, ca. 7 km ENE of Puerto Chimo, 0°50–51'N, 66°02–06'W, 300 m, 9–14 Jul 1984, fl., *G. Davidse & J.S. Miller 27212* (holotype: US; isotypes: MO, NY, VEN n.v.).

Paradrymoniae ciliosae affinis; petiolo longiore, corolla lutea, corollae lobis suborbiculares non fimbriatis differt.

Herbaceous lithophyte, or low epiphyte. Stem densely pilose, trichomes reddish. Leaves opposite, very unequal in a pair, the small one scale-like, mostly early deciduous; the larger one: petiole purple, appressed

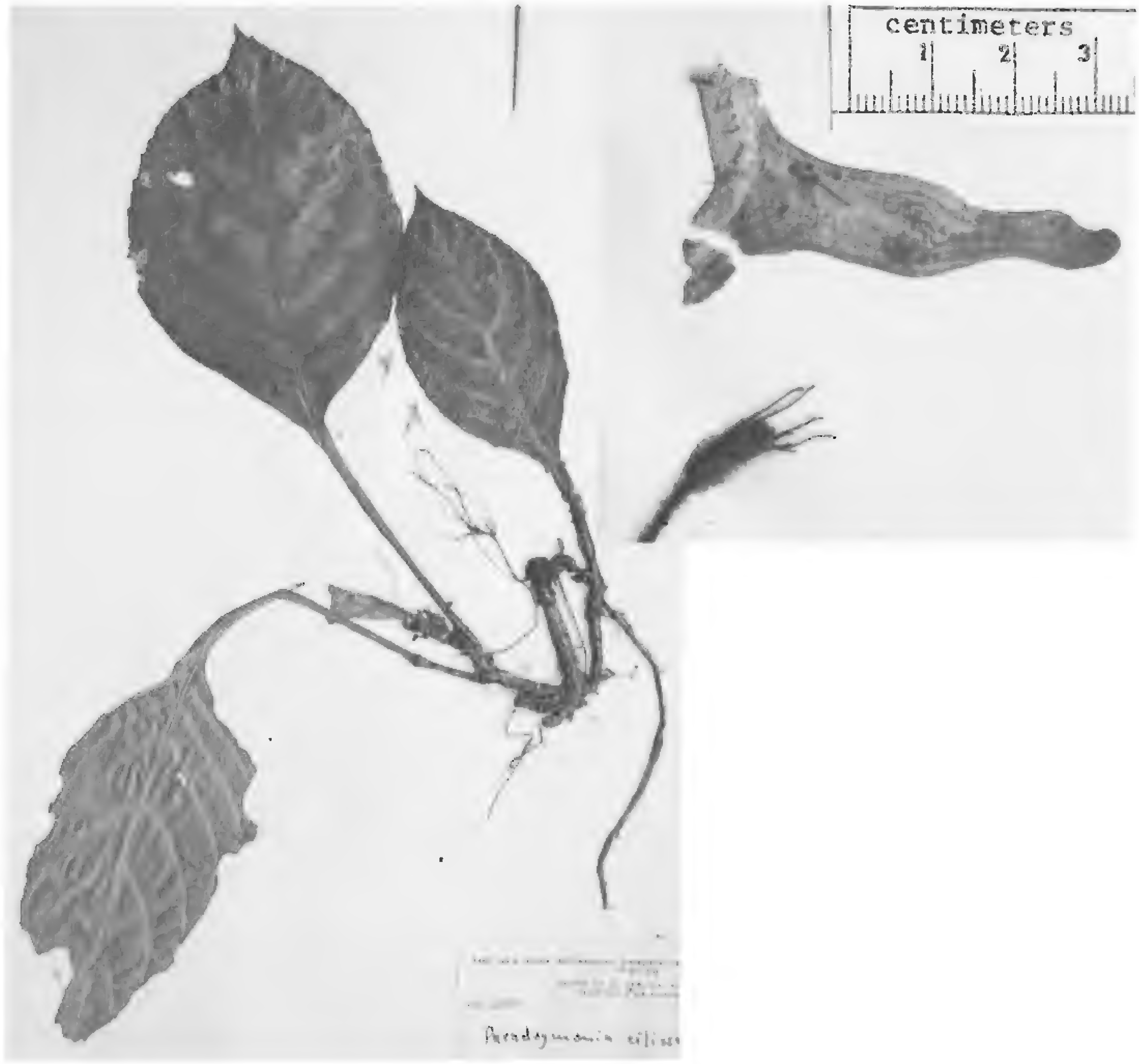


Fig. 2. ***Paradrymonia hamata, Maguire, Wurdack & Maguire 42563*** **(holotype: NY), blade of the middle leaf 9.5 cm wide; corolla & bud inset, B.** ***Maguire, R.S. Cowan & J.J. Wurdack 30621*** **(NY).**

pubescent to glabrous, 15–38 cm long; blade broadly ovate to ovate elliptic, 13–32 × 6–21 cm, cuneate and shortly decurrent at base, abruptly acuminate at apex, margins obscurely and loosely glandular serrate, glabrous, sometimes the veins sparsely appressed-pubescent abaxially, margin sparsely ciliate, with 9–13 main veins on each side of the midrib, impressed adaxially, conspicuous abaxially, tertiary venation not evident. Inflorescences axillary, fasciculate or short pedunculate, 12–25-flowered, peduncle 3–5 mm long, appressed-pubescent, bracts oblanceolate or lance-elliptic, acute at apex, 10–12 × 1.5–3 mm, minutely appressed-pubescent, pedicels densely appressed-pubescent, 2–3 cm long. Flower: calyx lobes free, 15–25 × 3–6 mm, narrowly to broadly lanceolate or lance-elliptic, narrowed to an acuminate attenuate apex, endured at the tip, sparsely ciliolate in the upper half, entire in the basal half, with a few endured blunt teeth toward the apex; corolla bright yellow, tubular, 4.3–4.5 cm long, glabrous inside except for the verrucose throat, pilosulous outside except toward the base, basal gibbosity 3.5 × 5 mm, ovate-oblong, glabrous, base narrowed, broader above to 7–8 mm diam., lobes suborbicular, 6 × 7 mm, glabrous inside, ventral lobe appressed-pilose outside, the others appressed-pilose toward base, otherwise glabrous outside; stamens

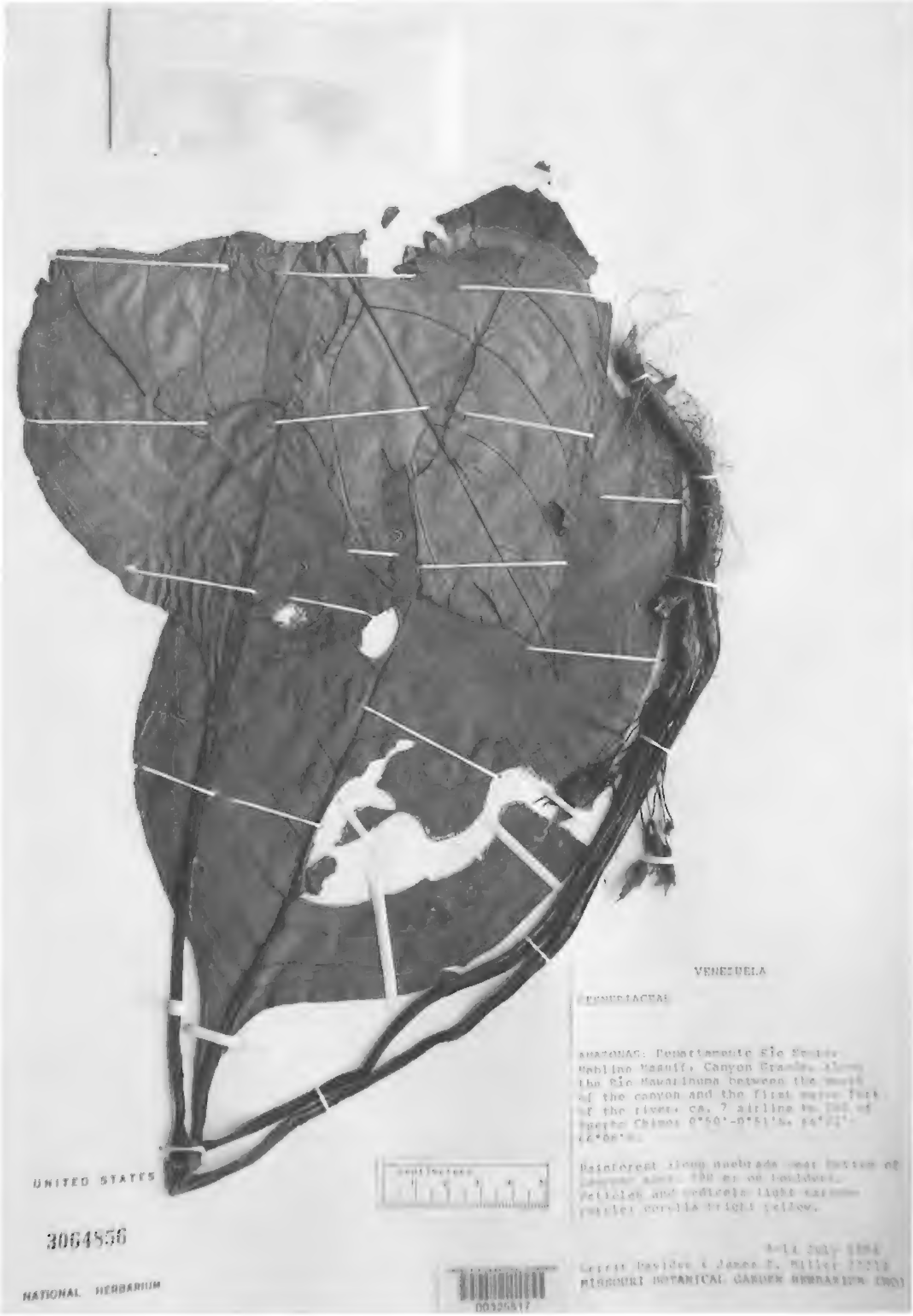

VENEZUELA
UNITED STATES
3064856
NATIONAL HERBARIUM
MISSOURI BOTANICAL GARDEN HERBARIUM (MO)

Fig. 3. *Paradrymonia lutea, Davidse & Miller 27212* (holotype: US).

4, inserted on the corolla, anthers 2 × 2 mm, cells pilose at base; disc reduced to a dorsal gland, glabrous; ovary densely sericeous, style 25 mm long, glabrous at base, sparsely pilose toward apex, stigma verrucose. Fruits not seen.

Distribution.—*Paradrymonia lutea* grows on boulders in forest or as a low epiphyte at 150–1250 m on the Neblina Massif, Amazonas (Venezuela).

I have not seen a single corolla and rely on careful notes taken by Julian Steyermark in the description of the corolla and androecium. *Paradrymonia lutea* resembles *P. ciliosa* from which it differs mainly by the bright yellow (vs. white corollas), the bracts and sepals oblanceolate or lance-elliptic (vs. narrow triangular), and the leaf blades that are broadly ovate to ovate elliptic (vs. oblanceolate) and cuneate (vs. long attenuate) at base. The bright yellow corollas separate *P. lutea* from the other species of subg. *Paradrymonia* from Venezuelan Guayana. This species was "sp. A" in Feuillet & Steyermark (1999).

Etymology.—The epithet *lutea* refers to the bright yellow corolla.

Paratypes: **VENEZUELA. Amazonas: Depto. Río Negro:** Cerro de la Neblina, foothill of South slope of North arm, above Puerto Chimo camp, 0°50'N, 66°07'W, 150–500 m, 14 Feb 1984, fl., *R.L. Liesner 15896* (MO, US, VEN); Cerro de la Neblina, north base of Pico Cardona, 0°49'N, 66°0'W, 1250 m, 21–24 Mar 1984, fl., *R.L. Liesner & B. Stannard 16895* (MO, US, VEN).

4. Paradrymonia tepui Feuillet, sp. nov. (**Fig. 4**). Type: VENEZUELA. Amazonas. Depto. Río Negro: Cerro Aracamuni, summit, Proa Camp, in ravines and near edge of tepui, 01°32'N, 65°49'W, 1400 m, 31 Oct 1987, fl. & fr., *R.L. Liesner & G. Carnevali 22679* (holotype: US; isotype: MO).

Paradrymoniae ciliosae affinis; lamina ovata vel late elliptica, basi breviter decurrente, sepalis apice linearibus differt.

Terrestrial herb, lithophyte, or low epiphyte. Stem densely pilose, trichomes reddish. Leaves opposite, very unequal in a pair, the small one scale-like, mostly persistent; the larger one: petiole 14–23 cm long, glabrescent; blade obovate to broadly elliptic, 14–30 × 6.5–13, cuneate and briefly decurrent at base, obtuse to acuminate at apex, margin minutely and loosely serrate, glabrous except abaxially on veins, margin ciliate, 7–10 main veins on each side of the midrib, midrib raised on both surfaces, veins raised or impressed on both surfaces. Inflorescences axillary, densely fasciculate on short peduncle; peduncles 1–1.5 cm long; bracts similar to the sepals; pedicels sparsely appressed pilose. Flowers: sepals greenish tan tinged with red, oblanceolate to lance-elliptic, narrow-triangular acuminate at apex, 1.7 × 0.4 cm, sparsely pilose, few glandular teeth limited to the acumen; corolla (seen only in bud) white, hyaline-pilose, basal gibbosity 5 × 3 mm, tube 2 cm long, edge of barely opening lobe undulate. Fruit subglobose, greenish tan, tinged with red.

Distribution.—*Paradrymonia tepui* has been collected on slopes and summit of a tepui, Cerro Aracamuni, in the Dept. Río Negro (Amazonas, Venezuela) between 600 and 1400 m. It was in flower and fruit in October.

Paradrymonia tepui resembles *P. ciliosa* by its general appearance: thick stem with usually short internodes, creeping on the substrate, strongly unequal leaves in a pair, the larger ones with long petioles, short inflorescence peduncles in the leaf axils, and creamy white corollas. *Paradrymonia tepui* differs from *P. ciliosa* by the leaf blade ovate to broad-elliptic, briefly decurrent at base, the inflorescence densely multiflowered, and the sepals linear-acuminate. The shape of the leaves and the sepals oblanceolate to lance-elliptic and narrow-triangular acuminate separate *P. tepui* from other species of subg. *Paradrymonia* from Venezuelan Guayana. This species was "sp. D" in Feuillet & Steyermark (1999).

Etymology.—This species is named tepui, a noun in apposition, after the location of the three known collections at the summit or on the slopes of a tepui.

Iconography.—See Fig. 493 in Feuillet and Steyermark (1999).

Paratypes: **VENEZUELA. Amazonas: Depto. Río Negro:** Cerro Aracamuni summit, Proa Camp, near edge of tepui, 1°32'N, 65°49'W, 1400 m, 27 Oct 1987, calices, *R.L. Liesner & G. Carnevali 22530* (MO, US); Dept. Río Negro, slopes of Cerro Aracamuni, Quebrada Camp, Laja area, 1°24'N, 65°38'W, 600 m, 22 Oct 1987, fr., *R.L. Liesner & G. Carnevali 22324* (MO, US).

5. Paradrymonia yatua Feuillet, sp. nov. (**Fig. 5**). Type: VENEZUELA. Amazonas. Depto. Río Negro: Río Yatúa, at base of Piedra Arauicaua, 100–140 m, 3 Feb 1954, fl., *B. Maguire, J.J. Wurdack & G.S. Bunting 37466* (holotype: US; isotype: NY).

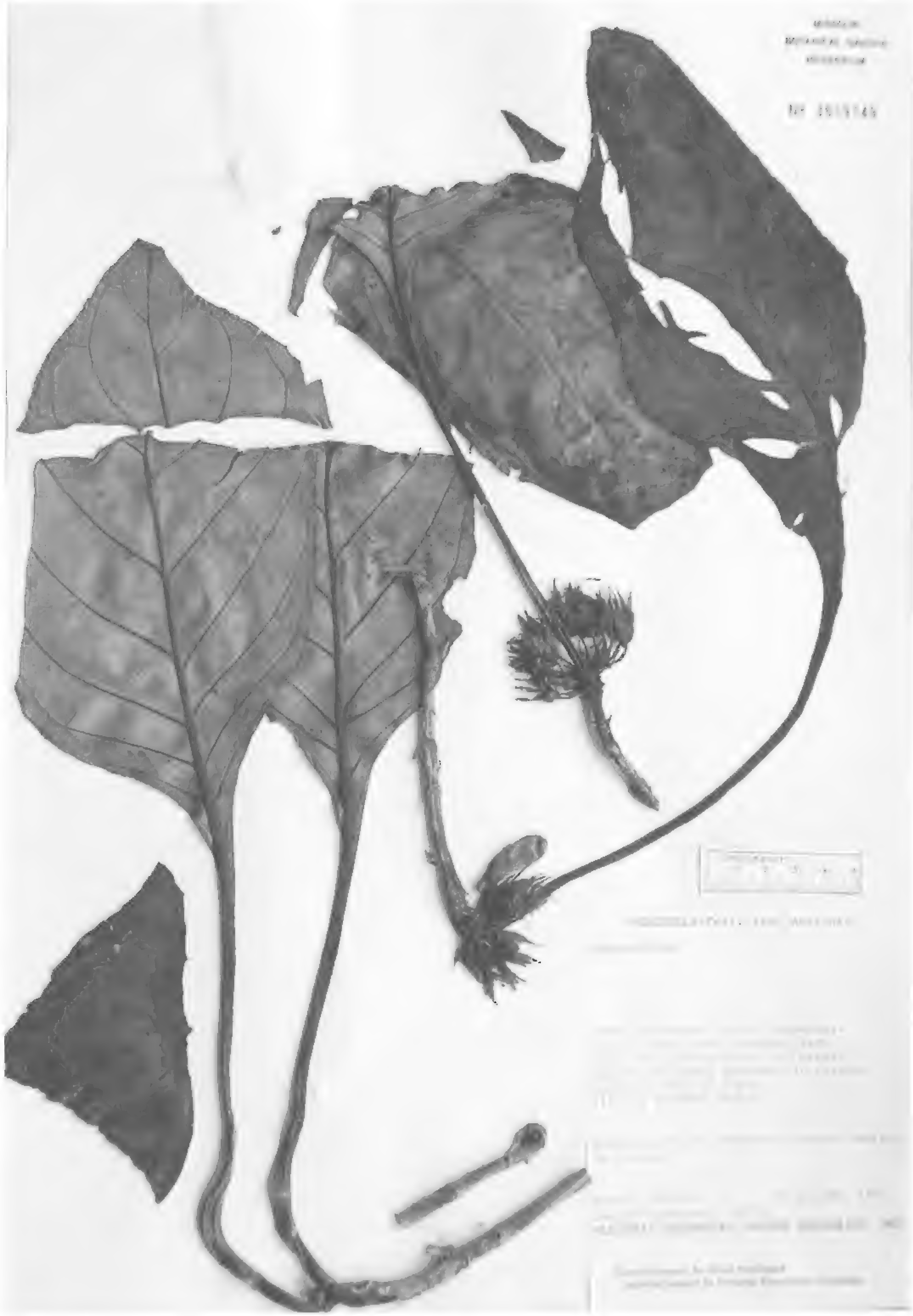


Fig. 4. *Paradrymonia tepui, Liesner & Carnevali 22679* (isotype: MO).

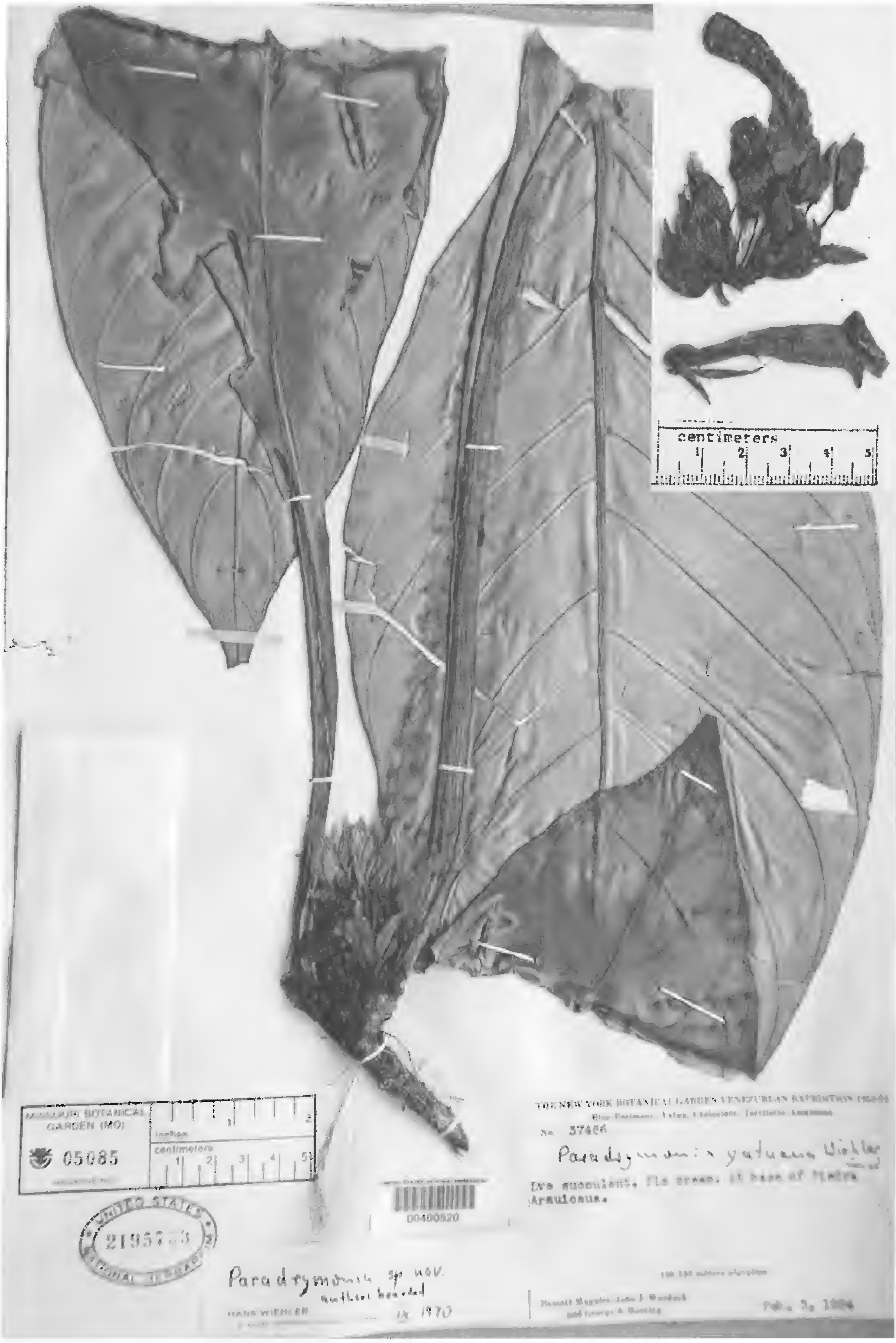

centimeters
1
2
3
4
5
MISSOURI BOTANICAL GARDEN (MO)
inches
centimeters
05085
2195753
UNITED STATES NATIONAL HERBARIUM
00400520
Paradrymonia sp. nov.
anthers bearded
HANS WIEHLER
IX 1970
THE NEW YORK BOTANICAL GARDEN VENEZUELAN EXPEDITION
No. 37466
Paradrymonia yatuana Wiehler
Lvs succulent. Fls green. At base of Piedra Araucaus.
Feb. 3, 1954

Fig. 5. *Paradrymonia yatua, Maguire, Wurdack & Bunting 37466* (holotype: US); flower inset, *Steyermark & G.S. Bunting 102546* (US).

Paradrymoniae ciliosae affinis; lamina foliorum lanceolata, inflorescentia pluriflora, sepalis oblanceolatis vel lanceo-ellipticis apice linearibus, corollae lobis suborbiculares non fimbriatis differt.

Herb saxicolous. Stem short pilose, trichomes hyaline. Leaves very unequal in a pair, the small one scale-like, often early deciduous; the larger one: petiole 13–30 cm long, 1 cm wide (life-measurement), glabrous; blade broadly obovate to elliptic or lanceolate, cuneate and then long decurrent into the petiole, acuminate at apex, margin entire or serrulate toward apex, glabrous both sides, 40–55 × 13–18 cm, midrib strikingly raised below, 12–13 main veins on each side of the midrib. Inflorescence axillary, densely fasciculate; bracts similar to the sepals; pedicels 1.5–3 cm, sparsely pilose. Flowers: sepals green, oblanceolate to lance-elliptic, long linear at apex, 2.5–2.8 × 0.9–1.1 cm, margin entire loosely ciliate, sparsely pilose; corolla creamy white, 6–6.5 mm long, basal gibbosity 8 × 3 mm, curved, tube 2–2.8 cm long, pilose outside with hyaline trichomes, lobes suborbicular, entire, 10 × 10 mm, undulate at margin, pilose at base outside with hyaline trichomes, otherwise glabrous, dorsal gland, entire, rounded, 2 mm long, 1 mm wide; anthers reniform-suborbicular; ovary slender ovoid, densely short strigose, trichomes purple, style 2.5 cm long, conspicuously short hirsute, trichomes dark. Fruit not seen.

Distribution.—*Paradrymonia yatua* has been collected at the base of Cerro Arauicaua, near Río Yatúa (Amazonas, Venezuela), between 100 and 150 m elevation.

Paradrymonia yatua resembles *P. ciliosa* by its general appearance: thick stem with usually short internodes, creeping on the substrate, strongly unequal leaves in a pair, the larger ones with long petioles, short inflorescence peduncles in the leaf axils, and creamy white corollas. *Paradrymonia yatua* differs from *P. ciliosa* by the leaf blade broadly obovate to elliptic or lanceolate (rather than oblanceolate), the sepals oblanceolate to lance-elliptic, long linear at apex (rather than linear-acuminate), the corolla lobes undulate at margin (rather than the ventral lobe and two dorsal lobes fimbriate). *Paradrymonia yatua* differs from *P. lutea* by its white corolla versus yellow, from *P. tepui* by its leaves ovate to broad elliptic versus oblanceolate and its green calyx versus tinged with red, and from the other species of subg. *Paradrymonia* from Venezuelan Guayana by its calyx lobes lacking a linear apex.

Etymology.—This species is named yatúa, noun in apposition, after the Río Yatúa near which the known specimens have been collected.

PARATYPES: **VENEZUELA. AMAZONAS: Depto. Río Negro:** Cerro Arauicaua, al pie y en las faldas inferiores, Río Yatúa, 1°35'N, 66°10'W, 125–150 m, 11 Apr 1970, fl., *J.A. Steyermark & G.S. Bunting 102546* (MO, NY, NY, US, VEN).

KEY TO THE SPECIES OF *PARADRYMONIA* SUBG. *PARADRYMONIA* IN THE GUIANA SHIELD AREA (EXCEPT *P. CILIOSA*, ALL RESTRICTED TO VENEZUELA, AMAZONAS)

1. Corolla bright yellow (Neblina Massif) ______ **Paradrymonia lutea**
1. Corolla white.
   2. Calyx lobes elliptic.
      3. Leaf blades ovate or broad-elliptic; calyx tinged with red (Cerro Aracamuni) ______ **Paradrymonia tepui**
      3. Leaf blades oblanceolate; calyx green (Río Yatúa) ______ **Paradrymonia yatua**
   2. Calyx lobes partly linear-acuminate.
      4. Corolla white with red trichomes (Cerro Marhuaca & Cerro Yapacana) ______ **Paradrymonia glandulosa**
      4. Corolla white with hyaline trichomes.
         5. Leaf blades broadly ovate to orbicular, suddenly decurrent to the petiole; calyx lobes acumen long filiform; corolla ventral lobe fimbriate, others crenate to entire at margin (Río Yatúa & Cerro Yapacana) ______ **Paradrymonia hamata**
         5. Leaf blades oblanceolate to elliptic, progressively long decurrent to the petiole; corolla 3 lobes fimbriate.
            6. Calyx lobes margin loosely glandular toothed, acumen short or long linear; corolla with the ventral and dorsal lobes fimbriate (large distribution in Central & northern South America) ______ **Paradrymonia ciliosa**
            6. Calyx lobes margin (including the long linear acumen) loosely fimbriate; corolla with only the ventral lobe fimbriate (Cerro Cuao) ______ **Paradrymonia sp. 1**

ACKNOWLEDGMENTS

This work could not have been completed without the help of the curators of the herbaria MO, NY, and VEN who made available to me the material in their care. Alain Chautems (G), Raul Gutierrez, John Clark (UNA) and Marcela Mora (UNA) provided helpful reviews. This paper is published as number 146 in the Smithsonian's Biological Diversity of the Guiana Shield Program publication series.

REFERENCES

Feuillet, C. 2009. Folia taxonomica 12. *Paradrymonia* (Gesneriaceae, Episcieae) from the Guiana shield: *P. maguirei,* a new species from Amazonas, and distribution and floral morphology of *P. maculata*. J. Bot. Res. Inst. Texas 3:133–138.

Feuillet, C. and J.A. Steyermark. 1999. Gesneriaceae. In: Steyermark, J.A., P.E. Berry, K. Yatskievych, and B.K. Holst. Flora of the Venezuelan Guayana, vol. 5. Missouri Botanical Garden Press, St. Louis. Pp. 542–573.

FOLIA TAXONOMICA 16. *DILKEA* (PASSIFLORACEAE) 1. *EPKIA*, A NEW SUBGENUS AND FIVE NEW SPECIES FROM WESTERN AMAZONIA AND THE GUIANAS

Christian Feuillet

Department of Botany, MRC-166
Smithsonian Institution
P.O. Box 37012
Washington, DC 20013-7012, U.S.A.
feuillec@si.edu

ABSTRACT

An introduction to *Dilkea* (Passifloraceae) is given and the new subgenus **Epkia** and three new species from western Amazonia are described: **Dilkea cuneata, D. ovalis,** and **D. tillettii;** as well as two new species from the Guianas: **Dilkea lecta** and **D. vanessae.** The species of subgenus *Epkia* have branches where the first internode after the bud scales is much longer than subsequent ones. A key to the subgenera of *Dilkea* is also given.

RÉSUMÉ

Une introduction à *Dilkea* (Passifloraceae) est présentée et le sous-genre **Epkia** et trois espèces nouvelles d'Amazonie occidentale sont décrits: **Dilkea cuneata, D. ovalis** et **D. tillettii;** ainsi que deux espèces des Guyanes: **Dilkea lecta** et **D. vanessae.** Les espèces du sous-genre *Epkia* ont des branches dont le premier entre-nœud après les écailles du bourgeon est plus long que les suivants. Une clé des sous-genres de *Dilkea* est aussi présentée.

RESUMEN

Se presenta una introducción al género *Dilkea* (Passifloraceae) y se describe el nuevo subgénero **Epkia** y tres nuevas especies de la Amazonia occidental: **Dilkea cuneata, D. ovalis** y **D. tillettii;** así como dos nuevas especies de las Guianas: **Dilkea lecta** y **D. vanessae.** Las especies del subgénero *Epkia* poseen ramas con el primer entrenudo tras las escamas de la yema más largo que los siguientes. Se proporciona también una clave para los subgéneros de *Dilkea*.

INTRODUCTION

Dilkea was named by Masters (1871) to honor his late friend Charles Wentworth Dilke, II (1810–1869), made baronet by Queen Victoria in 1862. Dilke was a patron of arts and sciences. He died in St Petersburg while representing England at the horticultural exhibition held there. His father, C.W. Dilke, I (1789–1864), was a founder of the Gardener's Chronicle.

Dilkea, with 7 species, is a genus of tribe Passifloreae. The species can easily be separated from the other American genera of the tribe based on the following characters suite: flowers with 4 sepals, 4 petals, 8 stamens, 4 carpels and styles, stamens inserted at the bottom of the tube or halfway up the short, 0–2 mm long androgynophore, and seeds that are neither flattened nor ornamented (Masters 1872; Killip 1938; Holm-Nielsen et al. 1988; Tillett 2003; Feuillet & MacDougal 2007). *Dilkea* has a large lowland distribution in Panama and South America, from Colombia to Mato Grosso and from Peru to Amapá, but has been little collected.

Dilkea Mast., Trans. Linn. Soc. 27:627. 1871. Type species: *D. retusa* Mast., Trans. Linn. Soc. 27:628. 1871. (for typification, see Killip 1938).

Shrubs, small trees, or lianas. Leaves always simple and unlobed, margin entire; petiole with a basal pulvinus. Flowers white; sepals 4; petals 4; operculum and limen lacking; androgynophore shorter than wide or lacking; stamens 8, inserted on the bottom of the floral cup or on a 1–2 mm long androgynophore; ovary sessile or usually on a short 1–2 mm long gynophore, styles 4, united at base. Fruits yellow to orange, baccate, ovoid or globose, apically rounded or with a conical acumen, pericarp coriaceous, placentas 4, seeds

J. Bot. Res. Inst. Texas 3(2): 593 – 604. 2009

few, slightly bean-shaped or straight, not flattened, both ends similar, and sarcotesta thin, neither sclerified nor ornamented.

There is a great similarity in floral morphology within *Dilkea;* thus, one cannot separate species in the genus based on floral characteristics alone. Killip (1938) described *Dilkea parviflora* and commented: "I am inclined to think that further study and collecting will show that the four last species of the present treatment should be merged in one." Part of the problem, as suggested by Killip, resided in the small number of field collections, but instead of getting a synonymizing species as a result of better sampling, it appears that increased sampling is instead revealing new species.

Historically, nine species have been described within *Dilkea*. Masters (1871) published *D. acuminata* and *D. retusa* from Spruce's collections as new species within this new genus. Later, Masters (1872) described *D. wallisii* Mast., only after an illustration by Wallis, in his treatment of the Passifloraceae for *Flora Brasiliensis*. Few taxa have been published since then: *D. johannesii* by Barbosa Rodrigues (1888), *D. ulei* by Harms (1906), *D. glaziovii* (nom. nud.) by Glaziou (1909), *D. johannesii* var. *parvifolia* by Hoehne (1915), *D. parviflora* by Killip (1938), *D. magnifica* by Steyermark (1968), and *D. margaritae* by Cervi (1991). For more than 70 years, *D. ulei* has been treated as a synonym of *D. johannesii*. *Dilkea glaziovii* Mast. ex Glaz. (nom. nud.) was ignored, as *Mitostemma glaziovii* Mast. was considered to be in the right genus. Thus, at present seven species and one variety are circumscribed within *Dilkea*.

Most recently, Holm-Nielsen et al. (1988) placed *D. acuminata*, *D. magnifica*, and *D. wallisii* in synonymy of *D. retusa*, keeping *D. johannesii* and *D. parviflora* as separate species on the basis of petiole, pedicel, and gynophore sizes. They had not seen the type of *D. parviflora* and therefore based their identification on Killip's description. In fact, the material cited from Ecuador and the illustration mostly belong to a new species described below as *D. cuneata*.

Recent gifts of *Dilkea* collections to the Smithsonian Institution herbarium (US) revealed an unexpected diversity of vegetative morphology from the Loreto region in Peru and from the Guianas. This was confirmed in February 2009 by a visit to the herbarium collections at the Missouri Botanical Garden, especially rich in *Dilkea* from western Amazonia. Several species are woody vines that exhibit continuous monopodial growth and climb by the mean of strong tendrils apically 3-fid but early deciduous if they do not find a support. They represent what is considered here to be *Dilkea* subg. *Dilkea*. Another group of species, including the five new species described below, have similar flower and fruit morphology, but are small trees and exhibit a unique "modular" growth pattern that is rare in the Passifloraceae. The stems have strongly modular growth; the modules have at the base very short internodes with bud scales, then a long internode, and apically a swelling with short internodes, leaves, and inflorescences and ramifications. In most cases, the terminal meristem aborts and the growth continues through 1(–3) subterminal vegetative buds. This results in the overall appearance of a treelet with one stem and tiers of leaves, evidence of rhythmic or modular growth (field studies are needed to ascertain this) and sometimes a few modular branches 1–2 meters above ground. The plants are self standing and do not have tendrils.

In the text below, the world "lacking" means "not present in the taxon" and the expression "not seen" means "not present in the collections studied."

Subgenus *Epkia*

Dilkea subg. **Epkia** Feuillet, subg. nov. Type: *Dilkea cuneata* Feuillet (see below).

Subgenus *Epkia* ad *Dilkea pertinens*; ab subgenere *Dilkea* capreoli nulli, internodio inter gemmae squamae et folii multo elongato et ceteris internodiis brevissimis distinctus.

The species of subgenus *Epkia* are mostly small trees (or shrubs or scandent shrubs). In each branch, the first node above the numerous acicular bud scales is much longer than the following internodes and there is no transition in leaf shape and morphology. The long internodes become shorter in the branches of higher ramification order. The large leaves are alternate in a terminal cluster on the club-shaped apical part of every growth unit. The flowers are similar to those of the other species of *Dilkea* by their color and general morphology.

Collection labels usually say "tree" or "small tree" with noted sizes from <1–8 m tall, but are occasionally labeled as "shrub." I think this is indicative of a small size rather than a clumping habit of the plants. From pictures taken in the wild, the young plants 0.5–1.5 m tall have a main stem about 1 cm in diameter, showing many leaves in a few tiers. A 1.5-m tall plant of *Dilkea cuneata* photographed in Peru has 4 tiers of 7–20 large leaves. The lower is at ground level and the upper one is at the apex of the plant. The picture shows the whole plant and it is not possible to decide if the stem has a monopodial and rhythmic growth or a sympodial, modular growth. The branches, as demonstrated by herbarium specimens, are modular and little branched constructions. Each module exhibits a unique morphology. At the base are usually more than 10 acicular bud scales followed by a long internode and the apical part with short internodes bearing the leaves and axillary flowers or short inflorescences.

The name of subgenus *Epkia* honors through his initials **E**llsworth **P**aine **K**illip (1890–1968) author of *The American Species of Passifloraceae* (1938), a two-volume masterpiece covering 366 species.

KEY TO THE SUBGENERA OF *DILKEA*

1. Lianas or scandent shrubs; tendrils trifid at apex; first internode shorter than or as long as the following internodes; stamens inserted at the bottom of the hypanthium. ______ **Dilkea** subg. **Dilkea**
1. Small trees or shrubs or scandent shrubs; without tendrils; first internode much longer than the following internodes; stamens inserted on a 1–2 mm long androgynophore. ______ **Dilkea** subg. **Epkia**

New species

Three new species from western Amazonia and two from the Guianas are here described in subgenus *Epkia*. More species of *Dilkea* are still undescribed.

1. Dilkea cuneata Feuillet, sp. nov. (**Fig. 1**). TYPE: PERU. JUNÍN: Cahuapanas, on Río Pichis, 340 m, 30 Jul 1929, fr., *E.P. Killip & A.C. Smith 26730* (HOLOTYPE: US).

= *Dilkea parviflora* sensu Holm-Nielsen, Jørgensen & Lawesson 1988, in part; not Killip 1938.

Haec ad subgenero Epkia pertinens. Petiolo solo pulvino Dilkeae tillettii affinis. Lamina foliorum 25–50 × 10–15 cm, anguste oblanceolata, in dimidio inferiore anguste triangulari sed basi abrupte obtusa vel rotunda differt.

Treelets 1–5 m tall, monocaulous or branched. Plant glabrous throughout. Stems with a long internode 6–20 cm long (2.5 cm in *Gentry et al. 54258*), 0.4–0.6 mm thick, followed by short ones 0.2–0.5 cm long. Tendrils lacking. Stipules not seen. Leaves in terminal clusters; petiole reduced to the pulvinus 0.8–1.5 cm; blade narrowly cuneate to cuneate, 28–53 × 10–13.5 cm, short to long attenuate and then abruptly ending at base, apex acute to rounded and acuminate, acumen 5–15 mm long, margin entire, drying olive-green adaxially, yellowish brown abaxially, midrib and veins raised on both surfaces and yellowish when dry, 12–25 main veins on each side of the midrib. Inflorescences subterminal; pedicels about 5 mm long, elongating 7–10 mm under the fruit; bracts not seen. Flowers scented; hypanthium 0.5–1.8 cm long, funnel-shaped, 0.4–0.8 cm diam. at throat; sepals 4, white, oblong, 2.5–3.5 × 0.7–1 cm, obtuse to acute at apex, ciliate at margin; petals 4, white, oblong, 2.5–3.5 × 0.5–0.7 cm, obtuse to acute at apex, united at base, thinner than sepals; corona white, in 2 rows, outer one of free straight filaments, 1–3 cm long, seldom curled at apex, inner one membranous, laciniate at margin, laciniae floccose; androgynophore 1–2 mm long; stamens 8, filaments white, ca. 3 cm long, united at base for 1 mm, anthers sulphur yellow, 8 mm long, dorsifixed near base; gynophore 1–2 mm long; ovary ovoid, 5–6 mm long, styles 4, ca. 3.5 cm long, united for 1/3–1/2 of their length, stigmas capitate, sulphur yellow. Fruits spherical or slightly ovoid, apiculate, 2.5–3 cm long, yellow, pericarp coriaceous, about 0.5 mm thick, glabrous; seeds few, elongate, 1.5–1.7 × 0.7–0.8 cm, brown.

Distribution and ecology.—*Dilkea cuneata* is a western Amazonian species known from Ecuador (Morona-Santiago) and Peru (Junín, Loreto, and Pasco), in primary forest on terra firme, at 100–700 m of elevation. It is documented blooming in February, June, July, and November, and fruiting in January to April, June, July, and October.

Several specimens lacking flowers have been misidentified as belonging to the Theophrastaceae *Clavija*

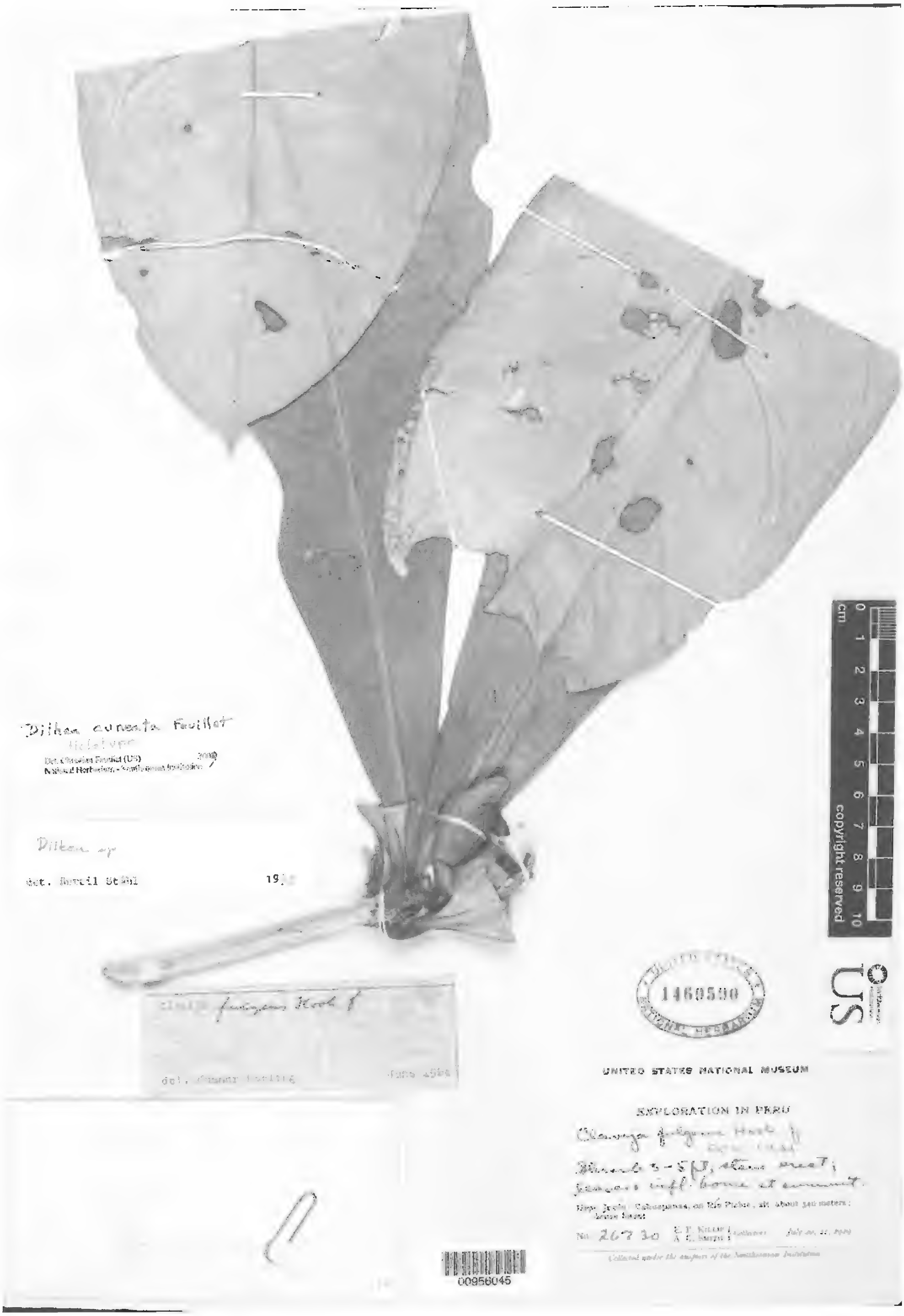

Dilkea cuneata Feuillet
holotype
National Herbarium - Smithsonian Institution
Dilkea sp.
19
Dilkea fuligena Hook. f.
cm
0 1 2 3 4 5 6 7 8 9 10
copyright reserved
1460590
US
UNITED STATES NATIONAL MUSEUM
EXPLORATION IN PERU
No. 26730
E. P. Killip
A. C. Smith
Collected under the auspices of the Smithsonian Institution
00956045

Fig. 1. *Dilkea cuneata,* holotype Killip & Smith 26730 (US).

fulgens Hook. F. (including by Killip in 1931), *Clavija lehmannii* Mez, *Clavija poeppigii* Mez, to *Passiflora* L., and even as a member of the Ranales. Some specimens have been identified as *Dilkea parviflora* (Holm-Nielsen et al. 1988) and *Dilkea wallisii* (Killip 1938) although those two *Dilkea* species are lianas. Nevertheless, *D. cuneata* clearly represents a new species from western Amazonia. Interestingly, *D. cuneata* has some of the largest leaves and of the smallest flowers in the genus. The growth units have a 15–25 cm long internode between the bud scales and the leaves and all the leaves are crowded toward the apex with internodes shorter than or equal to twice the diameter of the petioles. The congested inflorescence at the end of a branch is not terminal, but in fact consists of 2 or 3 axillary, subsessile, pauciflowered inflorescences. Aestivation of the two outer sepals is valvate, this pair surrounding the two inner sepals.

Etymology.—The epithet "cuneata" refers to the leaf blades basal half that are long triangular.

PARATYPES: **ECUADOR. Morona-Santiago:** Taisha, 500 m, 14 Feb 1962, fl. & fr., *P.C.D. Cazalet & T.D. Pennington 7771* (B, K, NY, US); 8–10 km NNW of military camp, 2°21'S, 77°31'W, 650–700 m, 16 Jun 1980, fr., *J. Brandbyge & E. Asanza 31937* (AAU). **PERU. Loreto:** Biological Station Río Blanco, 4°20'S, 72°45'W, 150 m, 12 Sep 1985, fr., *R. Vásquez, J. Ruiz & N. Jaramillo 6714* (MO, MYF); Maynas, Las Amazonas, Explornapo Camp, 3°20'S, 72°55'W, 100–140 m, 3 Mar 1991, fr., *J.J. Pipoly, R. Vásquez, N. Jaramillo, C. Grández, J. Ruiz & R. Ortíz 14165* (MO); Maynas, Las Amazonas, Explornapo Camp, 3°15'S, 72°54'W, 140 m, 20 Nov 1991, bud, *R. Vásquez 17568* (MO); Maynas, Las Amazonas, Quebrada Sucusari, Explornapo Camp, 3°20'S, 72°55'W, 140 m, 17 Apr 1991, fr., *R. Vásquez & N. Jaramillo 16095* (MO); Maynas, Iquitos, Alpahuayo, 73°30'W, 4°10'S, 150 m, 6 Jun 1985, fl., *R. Vásquez, J. Ruiz & N. Jaramillo 6608* (HUA, MO, MYF, US); Maynas, Iquitos, Alpahuayo, 73°30'W, 4°10'S, 150 m, 24 Mar 1992, st., *R. Vásquez, S.A. Vásquez & N. Jaramillo 18135* (MO); Maynas, Iquitos, Santa Maria de Ojeal, 10 km below mouth of Río Nanay, 16 Jun 1976, fr., *S. McDaniel & M. Rimachi 20725* (MO); Maynas, Yanamono, Río Amazonas, 3°25'S 72°50'W, 130 m, 12 Jun 1986, fr., *A.H. Gentry, R. Vásquez & N. Jaramillo 54258* (MO); vicinity of Requena, Fundo Canama, E of Río Ucayali, 17 Jul 1961, bud, *M.E. Mathias & D. Taylor 5552* (F, LA, MO); Maynas, Las Amazonas, Río Sucusari, 3°20'S 72°55'W, 116 m, 7 Nov 1989, fl., *R. Vásquez & N. Jaramillo 13077* (MO, MYF, P). **Pasco:** Oxapampa, Palcazu Valley, Iscozacin, 75°15'W, 10°12'S, 400 m, 26 Jan 1984, st., *R.B. Foster 9545* (MO).

2. Dilkea lecta Feuillet, sp. nov. (**Fig. 2**). TYPE: FRENCH GUIANA: near Organabo, primary forest on white sand, 20 Jun 1995, fr., *D. Loubry 2422* (HOLOTYPE: US; ISOTYPES: CAY, MPU).

=? *Dilkea johannesii* var. *parvifolia* Hoehne, Comm. Linh. Tel. Matto Grosso ao Amazonas, Annexo 5, Bot. pt. 5:73; pl. 111. 1915. TYPE: BRAZIL. MATO GROSSO: Rio Juruena, *Comm. Linh. Tel. Matto Grosso Expedition 5433* (SP).

Haec ad subgenero Epkia pertinens. Lamina foliorum parva, angusta, 8–14 × 2–4 cm differt.

Treelets with branches sometimes passive climbers, up to 3 m tall. Whole plant glabrous. Stems with a long internode 1.3–5 cm long, followed by short ones about as long as once their diameter or less. Vegetative bud ca. 2 mm above the leaf axils, bud scales acicular to narrow-triangular 3–5 mm long. Tendrils lacking. Stipules not seen. Leaves in terminal clusters; petiole usually reduced to the pulvinus, occasionally up to 0.6 cm long, glands not seen; blade narrow oblanceolate, cuneate, 8–17 × 2–5 cm, long attenuate, apex acute, long acuminate, margin entire, midrib and veins raised on both surfaces and yellowish when dry, 8–12 main veins on each side of the midrib. Inflorescences subterminal; pedicels not seen. Flowers not seen (see below); gynophore 1–2 mm long under the fruit; styles 4, united only at base. Fruits spherical, apiculate, 3–3.5 × 2.5–3 cm, color not documented, pericarp coriaceous, about 0.5 mm thick; developed seeds not seen, ovules flat, 2 per placenta.

Distribution and ecology.—*Dilkea lecta* is known from the Lely Mountains in eastern Surinam and from central and northwestern French Guiana, and Brazil (Matto Grosso). The ecology is different between the four collections. *Loubry 2422* was collected in primary forest on white sand, on the coastal plain, at low elevation (according to the map the whole area is below 50 m); *Larpin 1058* is from low forest island on the northern slope of a granite outcrop (inselberg) at 340 m; *Mori & Bolten 8541* was collected between 2 plateaus of a mountain range between 500 and 700 m, and *Granville & Crozier 13648* is from middle to high ridge forests on schist, quartzite, and conglomerate at 400 m. The two localities in French Guiana share a low amount of available water due to the texture of the soil, white sand without visible amount of humus causing excellent and fast drainage and maximum light reflection toward leaf undersurface in one case and the dark granite slope preventing water storage and favoring evaporation.

Dilkea lecta is distinguished from *D. cuneata* by its leaves three times smaller and by the internode modu-

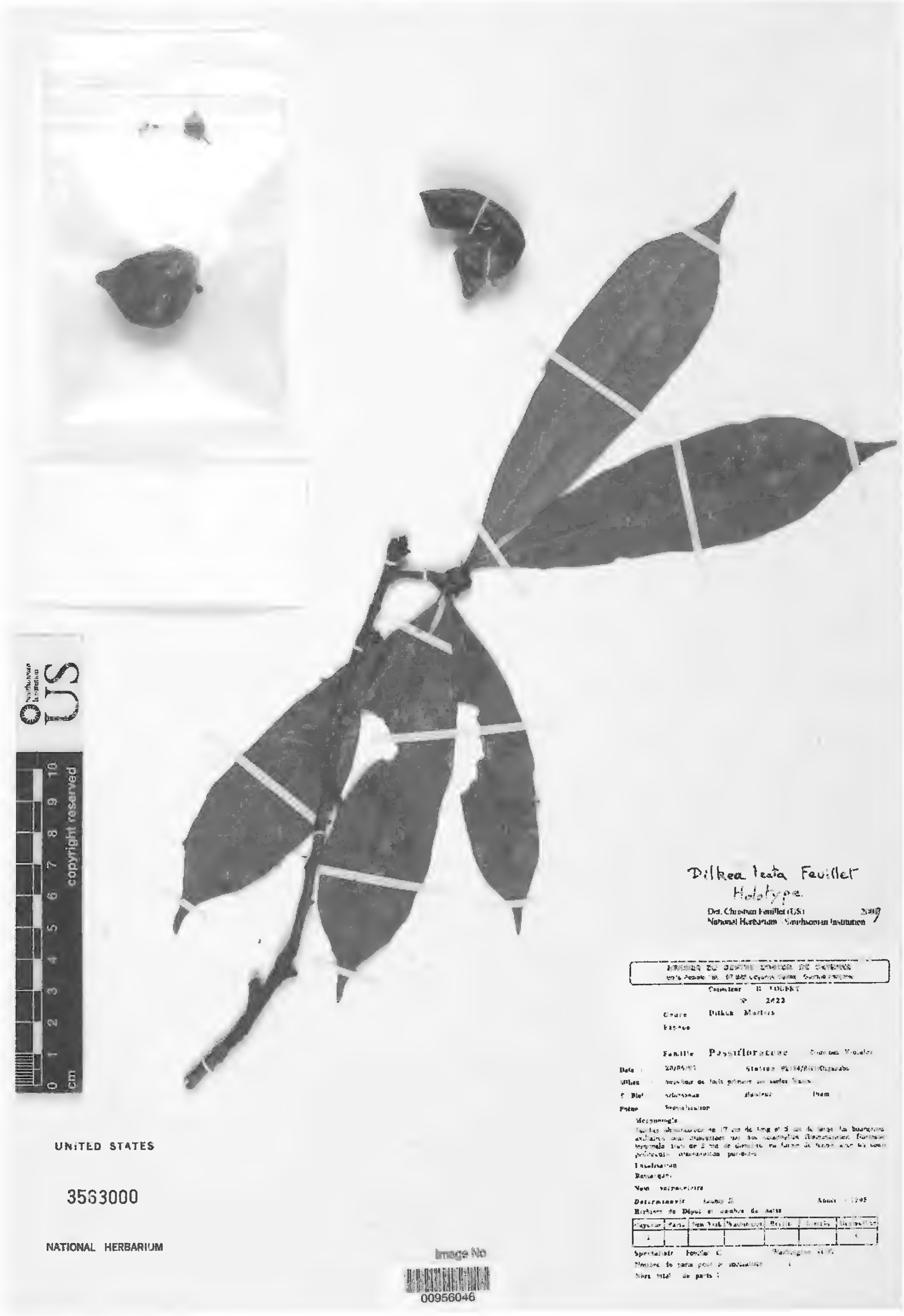

US
copyright reserved
cm
0 1 2 3 4 5 6 7 8 9 10
Dilkea lecta Feuillet
Holotype.
Det. Christian Feuillet (US) 2009
National Herbarium - Smithsonian Institution
Collecteur B. LOUBRY
N° 2422
Genre Dilkea Masters
Famille Passifloraceae
UNITED STATES
3563000
NATIONAL HERBARIUM
Image No
00956046

Fig. 2. *Dilkea lecta*, holotype *Loubry 2422* (US).

larity so characteristic of subg. *Epkia*. While this branching pattern is less obvious than in the other species of subgenus *Epkia*, it is still visible. Plants of *Dilkea lecta* are shrubs likely with one main trunk (*Granville & Crozier 13648* and *Loubry 2422*), yet able to passively climb on small trees (*Larpin 1058* and *Mori & Bolten 8541*).

Hoehne (1915) gave a brief description and a diagnostic illustration of *Dilkea johannesii* var. *parvifolia*. This is most likely a synonym of *D. lecta*. Based on Hoechne's description one can infer the following: leaf blades convex between veins, with small red dots underneath, pedicels slightly more than 1 cm long, flower with hypanthium slightly asymmetric at base), sepals and petals of similar length, corona in 2 rows, at least the inner one inserted low in the hypanthium, outer row of filaments ligulate, slightly exerted (more so than the stigmas), inner one membranous at base, filamentose at apex, filamentose segments bare at basal 1/3 and upper 2/3 papillose; stamens shorter than the petals, inserted on a short androgynophore; short gynophore; ovary wide elliptic, styles united for 2/3 of their length (unlike *Mori & Bolten 8541*), stigmas spherical. Thus, based on these features, this species fits within my current circumscription of *D. lecta*.

Etymology.—The specific epithet "lecta," Latin for gathered, refers to the leaves grouped at the apex of the branches.

Paratypes: **SURINAM:** Lely Mountains, 175 km SSE of Paramaribo, 500–700 m, 19 Oct 1976, fr., *S.A. Mori & A. Bolten 8541* (NY, US). **FRENCH GUIANA:** Montagne des Nouragues Reserve, 4°3'N, 52°42'W, 340 m, 20 Apr 1992, st., *D. Larpin 1058* (CAY, US); Montagne de la Trinité, zone sud, Mana River basin, 4°34'N, 53°27'W, 400 m, 16 Jan 1998, fr., *J.-J. de Granville & F. Crozier 13648* (CAY).

3. Dilkea ovalis Feuillet, sp. nov. (**Fig. 3**). Type: PERU. Loreto: Maynas, Las Amazonas, 72°33'W, 3°25'S, 120–130 m, 25 Mar 1991, fr., *C. Grándes, G. Criollo & W. Criollo 2291* (holotype: MO).

Haec ad subgenero Epkia pertinens. Lamina foliorum elliptica, lata, 10–18.5 × 5–9 cm differt.

Shrub or small tree, 4–6 m tall; plant glabrous throughout. Stems with a long internode 3.5–12 cm long, followed by short ones 0.1–0.3 cm long. Tendrils lacking. Stipules not seen. Leaves in terminal clusters; petiole 0.5–2.3 cm long, pulvinate for less than half its length, glands not seen; lamina elliptic to slightly obovate, 7.5–25 × 3.5–10 cm, widely acute and then short cuneate at base, apex rounded with acumen 0.6–1.2 cm long, margin entire, minutely frilled when dry, midrib and veins raised on both surfaces, 6–12 main veins each side of the midrib. Inflorescences subterminal; pedicels under fruit 7–9 mm long; bracts not seen. Flowers not seen; gynophore under fruit about 1 mm long. Fruits spherical or slightly ovoid, apiculate, about 2.5 cm diam., yellow, pericarp coriaceous, about 0.5 mm thick, glabrous; seeds few, elongate, 1.8–2 × 0.8–0.9 cm, brown.

Distribution and ecology.—The three known collections have been made in northeastern Peru, Region of Loreto, Province of Maynas, at 140–180 m. It was in flower buds in July and fruiting in March.

Dilkea ovalis is easily set apart from other species in subgenus *Epkia* by leaf shape. In *D. ovalis*, the laminas are wide elliptic rather than cuneate or narrow elliptic. The pulvinus is a third to half the petiole total length. In the other long-petioled species, *D. vanessae*, the pulvinus represents less than the fifth of the total length.

Etymology.—This species is named *ovalis* because of the oval shape of its leaf blades.

Paratype: **PERU. Loreto:** Maynas, Iquitos, Allpahuayo–IIAP, 73°25'47"W, 3°57'19"S, 140 m, 26 Apr 1997, st., *R. Vásquez, O. Phillips, R. Rojas & A. Peña 23599* (MO); Maynas, Iquitos, Allpahuayo–IIAP, 73°30'W, 4°10'S, 150–180 m, 8 Jul 1991, fl. Buds, *R. Vásquez & N. Jaramillo 17188* (MO).

4. Dilkea tillettii Feuillet, sp. nov. (**Fig. 4**). Type: PERU. Loreto: Florída, Río Putumayo at mouth of Río Zubineta, ca. 200 m, Mar–Apr 1931, fl., *G. Klug 2100* (holotype: US; isotypes: MO, S).

= [*Dilkea grandifolia*] Killip ex Tillett, invalid: in sched., handwriting unknown 1986 on *Gentry et al. 37992* (F) "Tillet" and Tillett's handwriting 1993 on *G. Klug 2100* (MO) "ined. Isotypus."

Haec ad subgenero *Epkia pertinens*. Petiolo parte non-tumida carente *Dilkeae cuneatae* affinis. Lamina foliorum 34–35 × 11–12.5 cm, oblanceolata, in dimidio inferiore e basi triangulari differt.

Shrub or small tree 1–5 m tall, monocaulous or branched. Branches about 5 mm thick, with a long inter-

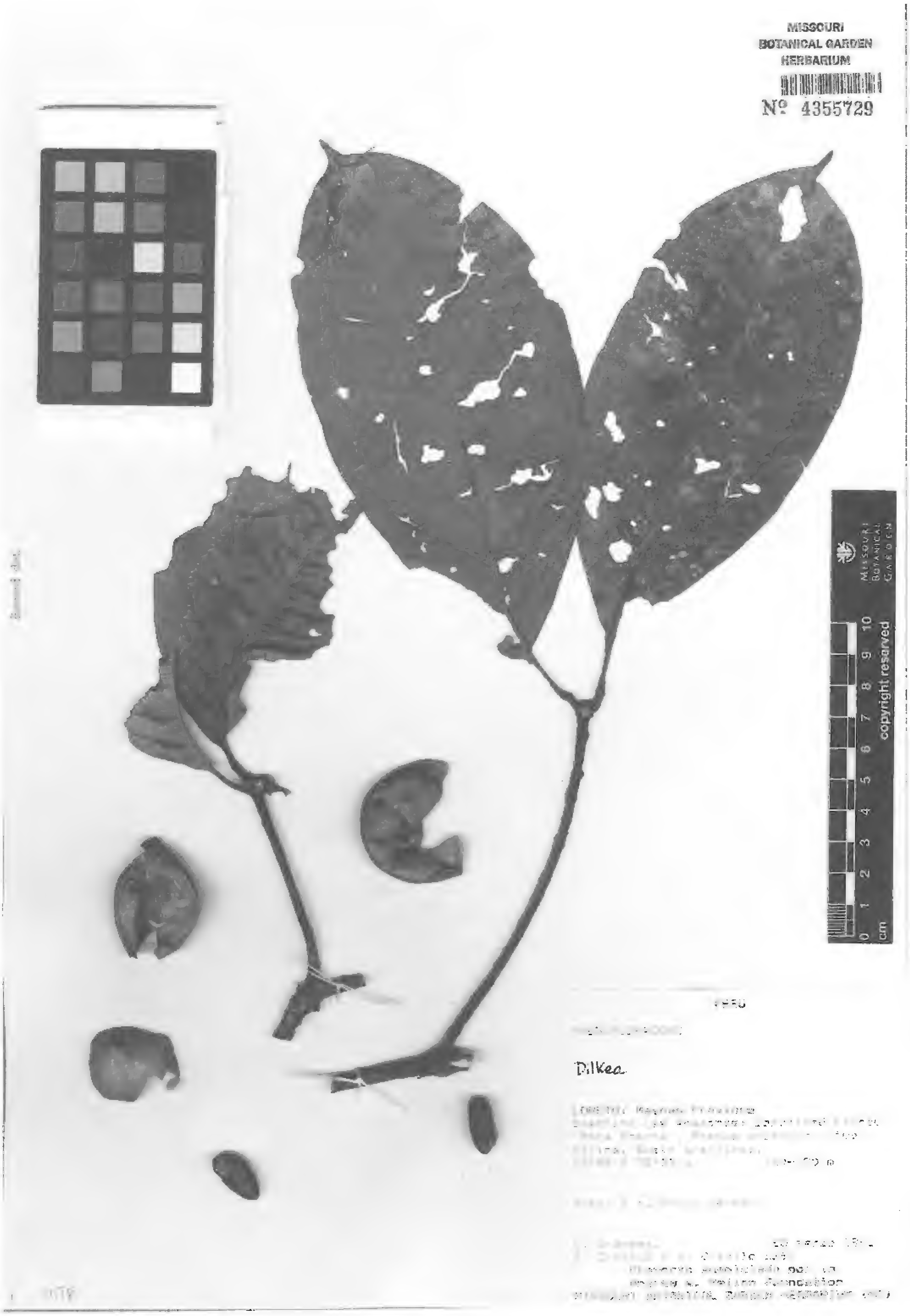

MISSOURI BOTANICAL GARDEN HERBARIUM
Nº 4355729
MISSOURI BOTANICAL GARDEN
copyright reserved
cm 0 1 2 3 4 5 6 7 8 9 10
PERU
Dilkea

Fig. 3. *Dilkea ovalis,* holotype Grández et al. 2291 (MO).

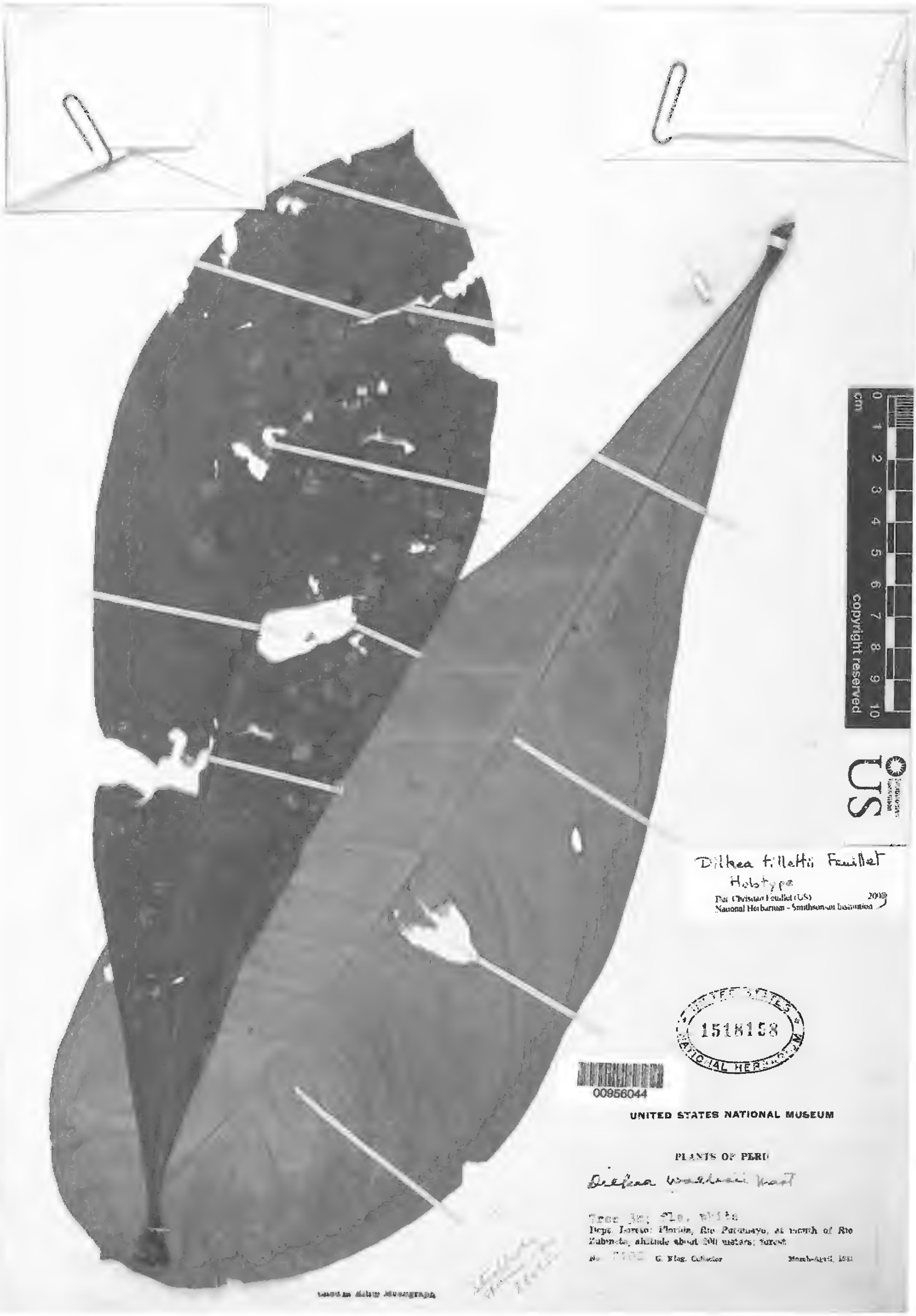

cm 0 1 2 3 4 5 6 7 8 9 10 copyright reserved
US
Dilkea tillettii Feuillet
Holotype
Det. Christian Feuillet (US) 2009
National Herbarium - Smithsonian Institution
1518158
NATIONAL HERB
00956044
UNITED STATES NATIONAL MUSEUM
PLANTS OF PERU
Tree 3m; fls. white
Dept. Loreto: Florida, Rio Putumayo, at mouth of Rio Zubineta, altitude about 200 meters; forest
G. Klug, Collector
March-April, 1931

Fig. 4. *Dilkea tillettii*, holotype *Klug 2100* (US).

node, the only partially visible >12.5 cm long (*Gentry et al. 37992* (F)), followed by short ones 0.2–0.5 cm long. Tendrils lacking. Stipules not seen. Leaves in terminal clusters; petiole 1.5–3 cm long, usually reduced to the pulvinus, glands not seen; lamina long oblanceolate, 35–43 × 12–15 cm, basal half long triangular regularly narrowing to the short pulvinate petiole, rounded at apex, blunt or with an acumen up to 1.5 cm long, margin entire, midrib and veins raised on both surfaces and drying more or less the same color as the rest of the leaves, 8–12 main veins each side of the midrib. Inflorescences subterminal; pedicels 0.5 cm long, 1 cm under the fruit, joined 0.2–0.3 cm from the base; bracts not seen. Flowers white, with a scent of lilac (*Barrier 84*); hypanthium 17–19 mm long, perianth separating and hypanthium getting shorter during late anthesis; sepals and petals 20–35 mm long, about 5 mm wide, two outer sepals green outside, white inside, aestivation valvate, two inner sepals white on both surfaces, aestivation valvate; corona white in two rows 3.5–4 cm long, inserted near base of hypanthium, tubular at base, outer row filaments slightly wavy, inner series heavily branched in the uppermost 1 cm, lateral segments very thin and tightly curled; stamens inserted in the bottom on the hypanthium, filaments about 3 cm long, anther 11× 1 mm, apiculate, base 2 mm sagitate; gynophore about 2 mm long; ovary 5 mm long, tapering at base, wider at apex, styles 3.5–4 cm long, stigma capitate. Fruits globose, 2.5–3 cm diam., apiculate, yellow, pericarp coriaceous, about 0.5 mm thick, glabrous; seeds few, elongate, 1.8 × 0.8 cm, brown.

Distribution and ecology.—Dilkea tillettii is known from Colombia (Amazonas & Caqueta), Ecuador (Morona-Santiago, Napo & Pastaza), and Peru (Loreto & Pasco) between 120–700 m. It was blooming in January and March–April, and fruiting in June to September and November.

Dilkea tillettii has obovate leaves that are cuneate in the basal half unlike *D. lecta* and *D. ovalis*. It is distinct from the other large-leaved species, *D. cuneata*, by the shape of the petioles and the shape of the leaf base. Although the pulvinus constitutes more than half the length of the petiole, it does not always encompass the entire petiole. The base of the lamina is the continuation of the narrow triangular leaf shape, neither suddenly ending as in *D. cuneata* nor decurrent. *Dilkea lecta* also has petioles more or less reduced to the pulvinus, but its laminas are at most half the size of those in *D. tillettii*.

Etymology.—Dilkea tillettii is named to honor Steve Tillett, botanist in Caracas (at MYF), and a specialist on the Passifloraceae who recognized this was a new species.

PARATYPES: **COLOMBIA. Amazonas:** Leticia, Amacayacu National Park, Quebrada de Agua Pudre, 3°47'S, 70°15'W, 200–220 m, 15 Nov 1991, fr., *J.J. Pipoly 16039* (MO). **Caqueta:** Araracuara, troche a Yari, 0°25'S 72°20'W, 200 m, 23 Jan 1989, st., *A.H. Gentry & M. Sanchez 64981* (MO). **ECUADOR. Morona-Santiago:** Taisha, 8–10 km NNW of military camp, 2°21'S, 77°31'W, 650–700 m, 16 Jun 1980, fr., *J. Brandbyge & E. Asanza 31937* (AAU); **Napo:** along Rd. between Coca & Río Tiguino, 76°52'W, 1°10'S, 300 m, 1 Mar 1992, fr., *T.B. Croat 72576* (MO); 77°45'W, 0°59'S, 200–300 m, 12 Apr 1997, fr., *K. Romoleroux, M. Bass, G. Villa & C. Vriesendorp 2841* (MO, QCA); Yasuni National Park, 0°55'S, 76°11'W, 200 m, 26 May–8 Jun 1988, fr., *C. Cerón & F. Hurtado 4258* (MO). **Pastaza:** Lorocachi, 3 km S of the military camp, 1°38'S, 75°58'W, 200 m, 23 May 1980, fr., *J. Brandbyge & E. Asanza 30659* (AAU). **PERU. Loreto:** Mariscal Ramón Castilla, Río Yuvineto, affluent of the Putumayo, territory of the Secoya Indians, in a purma near Bellavista, 17 Jan 1978, fl., *S. Barrier 84* (P); Maynas, Las Amazonas, 72°33'W, 3°25'S, 120–130 m, 17 Aug 1991, fr., *C. Grández & N. Jaramillo 2847* (MO, MYF); Maynas, Mishana, Río Nanay, 130 m, 20 Sep 1978, fr., *C. Díaz & N. Jaramillo 577* (MO); Maynas, Río Gueppi, northernmost tip of Peru, 200 m, 15 May 1978, fr., *A.H. Gentry, C. Diaz & N. Jaramillo 21931* (MO); Maynas, Yanomono, Río Amazonas, between Indiana and mouth of Río Napo, 3°28'S, 72°48'W, 130 m, 27 Jul 1982, fr., *A.H. Gentry, D. Alfaro & N. Jaramillo 37992* (F, MO). **Pasco:** Shiringamazu, ca. 20 km S of Iscozacin, Río Palcazu Valley, 10°20'S, 75°10'W, 300 m, 9 Jul 1988, st., *A.H. Gentry, C. Díaz & O. Phillips 63506* (MO).

5. Dilkea vanessae Feuillet, sp. nov. (**Fig. 5**). TYPE: FRENCH GUIANA. Pic Matecho, camp near the summit, 500 m, 14–15 Dec 2000, fr., *V. Hequet 1000* (HOLOTYPE: US; ISOTYPE: CAY).

Haec ad subgenero *Epkia pertinens*. Petiolo basi cum pulvino, lamina foliorum 20–21.5 × 7–8.5 cm, oblanceolata, cuneata differt.

Treelet 0.8–2 m tall, monocaulous or branched. Stems with a long internode 2–20 cm long, followed by short ones 0.2–0.3 cm long. Tendrils lacking. Stipules not seen. Leaves in terminal clusters; petiole 2–2.5 cm long, including the pulvinus 0.3–0.4 cm long, glands not seen; blade oblanceolate, cuneate, 19–21 × 7–8 cm, basal half triangular and then with a very narrow wing along the petiole until the swollen base, apex rounded and long-acuminate, margin entire, midrib and veins raised on both surfaces and light brown when dry, 7–9 main veins on each side of the midrib. Inflorescences subterminal; pedicels ca. 6 mm long in bud, joint

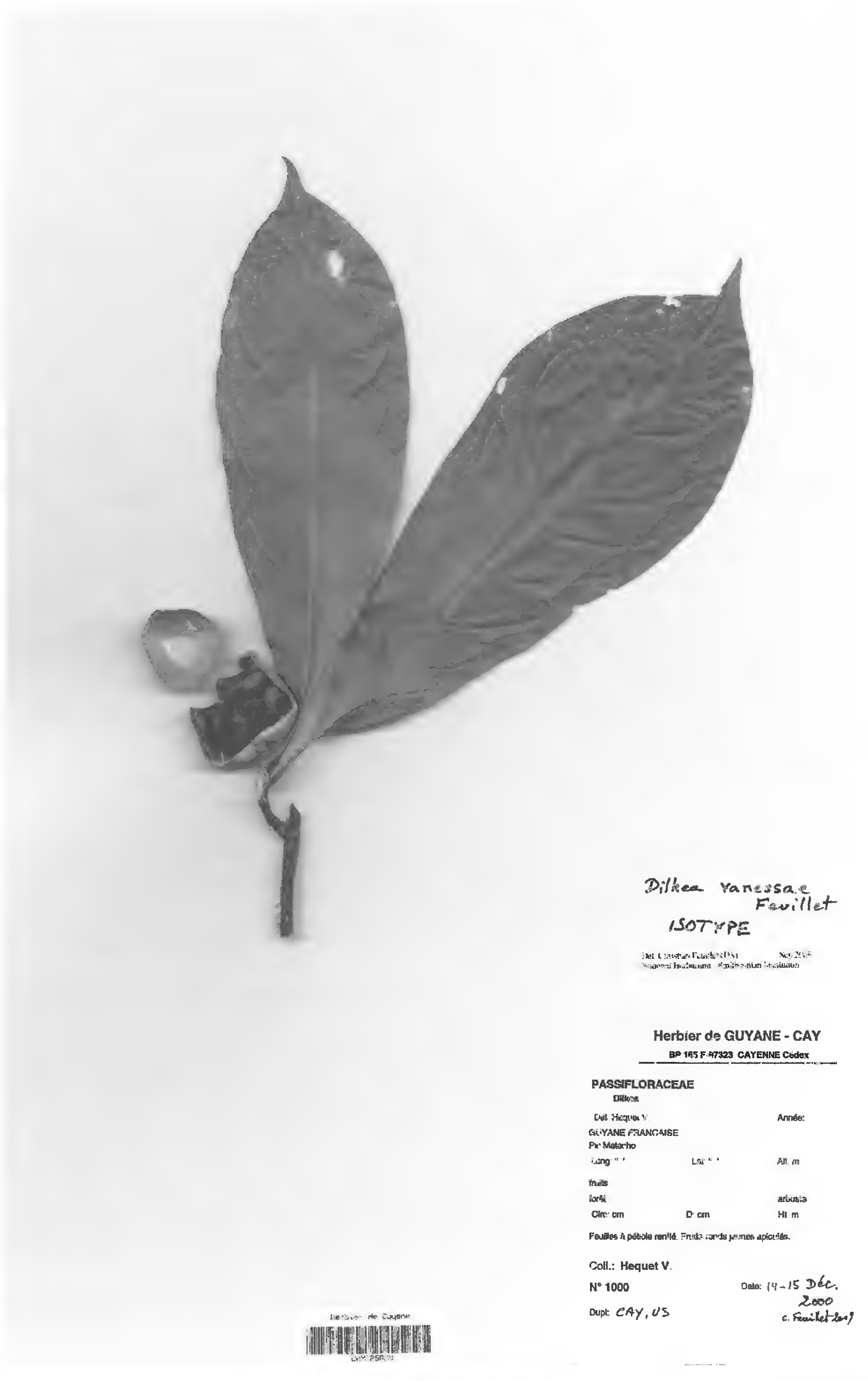

Dilkea vanessae
Feuillet
ISOTYPE
Herbier de GUYANE - CAY
BP 165 F-97323 CAYENNE Cédex
PASSIFLORACEAE
Dilkea
Det. Hequet V.
Année:
GUYANE FRANCAISE
Pic Matecho
Long
Lat
Alt. m
fruits
forêt
arbuste
Circ. cm
D. cm
Ht m
Feuilles à pétiole renflé. Fruits ronds jaunes apiculés.
Coll.: Hequet V.
N° 1000
Date: 14-15 Déc. 2000
Dupl. CAY, US
c. Feuillet 2009

FIG. 5. *Dilkea vanessae*, isotype *Hequet 1000* (CAY); petiole 25 mm long.

2 mm from the base; bracts not seen. Bud 1.8 × 0.9 cm. Flowers not seen; under the fruit, androgynophore and gynophore each 1 mm long. Fruits spherical, apiculate, about 3.5 × 3 cm, yellow, pericarp coriaceous, 0.2–0.3 mm thick, glabrous; seeds up to 8, elongate, 1.3–1.6 × 0.5–0.7 cm, reddish brown.

Distribution and ecology.—The only known collections were made in the rainforest, on Pic Matecho and Montagne des Nouragues, granitic outcrops in central French Guiana. They were fruiting in November and December (see discussion).

Dilkea vanessae has obovate leaves with a cuneate basal half.

The holotype label at US does not provide information about the date of collection. Vanessa Hequet, the collector of the holotype, noted that it was collected on 14 Dec 2000 (pers. comm.), but AUBLET, the database of the herbarium in Cayenne (CAY), lists the collection date as 15 May 2001. According to AUBLET and the few specimens I saw, *Hequet 972* to *1003* were all collected on 15 Dec 2000 at the same locality. Thus, the date 15 May 2001 represents an error in data entry.

Etymology.—The specific epithet is named after the collector of the type specimens, Vanessa Hequet, currently at NOU.

PARATYPES: **FRENCH GUIANA:** Droping Zone 5, near Road Régina - St Georges, 4°2'N, 52°1'W, 100 m, 25 Nov 1995, fr., *G. Cremers & J.-J. de Granville 14236 bis* (CAY); Mont Chauve, trail between base camp and the creek, 3°49'N, 52°44'W, 100m, 21 Apr 1997, fr., *G. Cremers & F. Crozier 15124* (CAY); Montagne des Nouragues, 52°42'W, 4°3'N, 7 Nov 1994, fr., *B. Riéra & A. Joly 2031* (CAY, P, U); Montagne des Nouragues, 52°42'W, 4°3'N, 150 m, 24 Oct 1995, fr., *O. Poncy 973* (P).

ACKNOWLEDGMENTS

I am grateful to Eduardo Garcia-Milagros who translated the abstract into Spanish. This work could not have been completed without the help of the curators of the herbaria AAU, CAY, MO, NY, and P who hosted me in their institution or made available to me the material in their care. I would like to thank Véronique Guérin (CAY), Stephanie Kiel (MO), and Ingrid Pol-Yin Lin (US) who provided the scans of the type specimens used for the illustrations. Reviews by Paul Hiepko (B), Shawn Krosnick (RSA), and Silvia Pérez (VEN) are greatly appreciated. This is number 151 in the Smithsonian's Biological Diversity of the Guiana Shield Program publication series.

REFERENCES

BARBOSA RODRIGUES, J. 1888. Ordo Passifloreae Endl. Vellosia 1, ed. 1:24–31; ed. 2 (1891):21–31.

CERVI, A.C. 1991. A study on Brasilian Passifloraceae, *Dilkea margaritae* A.C. Cervi, spec. nov. Candollea 46: 61–63.

FEUILLET, C. AND J.M. MACDOUGAL. 2007. Passifloraceae. In: K. Kubitzki, The families and genera of vascular plants. Springer, Berlin. 9:270–281.

GLAZIOU, A. 1909. Plantae Brasiliae centralis a Glaziou lectae. Liste des plantes du Brésil central recueillies en 1861–1895. Bull. Soc. Bot. France 56, Mém. 3d:297–392.

HARMS, H. 1906. Passifloraceae. In: E. Ule, II. Beiträge zur flora der Hylaea nach deb Sammlungen von Ule's Amazonas-Expedition. Verh. Bot. Vereins Prov. Brandenburg 48:184–186. ["1906," publ. 8 Mar 1907]

HOEHNE, F.C. 1915. Passifloraceae. Comm. Linh. Tel. Matto Grosso, Annexo 5:72–111.

HOLM-NIELSEN, L.B., P.M. JØRGENSEN, AND J.E. LAWESSON. 1988. Passifloraceae. In: G. Harling and L. Andersson (eds.), Flora of Ecuador 31:1–129.

KILLIP, E.P. 1938. The American species of Passifloraceae. Publ. Field Mus. Nat. Hist., Bot. Ser. 19:1–613.

MASTERS, M.T. 1871. Contributions to the natural history of the Passifloraceae. Trans. Linn. Soc. 27:593–645.

MASTERS, M.T. 1872. Passifloraceae. In: C.F.P. von Martius, ed. Fl. Bras. Soc. 13, pt. 1:530–654.

STEYERMARK, J.A. 1968. Nuevas especies de la Sierra Imataca y Altiplanicie de Nuria del Estado Bolívar y del Territorio Delta Amacuro. Passifloraceae. Acta Bot. Ven. 3:186–190.

TILLETT, S.S. 2003. Passifloraceae. In: P.E. Berry, K. Yatskievych, and B.K. Holst, eds. Fl. Ven. Guayana, vol. 7:625–667.

A NEW SPECIES OF *SCHEFFLERA* (ARALIACEAE) FROM THE VENEZUELAN ANDES

L.J. Dorr

National Museum of Natural History
Dept. Botany, MRC-166
Smithsonian Institution
P.O. Box 37012
Washington, DC 20013-7012, U.S.A.
dorrl@si.edu

Basil Stergios

Universidad Nacional Experimental
de los Llanos Occidentales
"Ezequiel Zamora" (UNELLEZ)
Mesa de Cavacas, Guanare
Estado Portuguesa 3323, VENEZUELA
basilven@cantv.net

ABSTRACT

A new species of *Schefflera*, **S. vanderwerffii** Dorr & Stergios, is described and illustrated. This new species is known only from the Ramal de Guaramacal in the Venezuelan Andes. Similarities and differences with respect to *S. pittieri* and *S. quinquestylorum* are discussed.

Key Words: Araliaceae, *Schefflera*, Venezuela, Andes

RESUMEN

Una nueva especie de *Schefflera*, **S. vanderwerffii** Dorr & Stergios, es descrita y ilustrada. Esta nueva especie es conocida únicamente del Ramal de Guaramacal en los Andes venezolanos. Se discuten las afinidades y diferencias con respecto a *S. pittieri* y *S. quinquestylorum*.

Palabras Clave: Araliaceae, *Schefflera*, Venezuela, Andes

Schefflera J.R. Forst. & G. Forst. (Araliaceae) as it is currently circumscribed is a very large genus comprising ca. 600 described species, but there is ample evidence that the genus is polyphyletic and divisible into at least five clades none of which correspond neatly with previously recognized segregate genera (Plunkett et al. 2005). Molecular data suggest that the Neotropical species of *Schefflera* form a single clade (Fiaschi et al. 2007), which in turn is part of a broader "Asian Palmate clade" (Plunkett et al. 2004, 2005; Wen et al. 2001 as "*Eleutherococcus-Dendropanax-Schefflera* group") that is at present defined more by molecular and geographic than morphological characters.

Schefflera is well represented in Venezuela. Species diversity is greatest in the Venezuelan Guayana where ca. 60 species occur (Frodin 1997, 2008) and relatively low in the Andes, Cordillera de la Costa, and adjacent Llanos. Presently, only five species of *Schefflera* are found in the Venezuelan Andes (Frodin 2008; see also Bono 1996; Dorr et al. 2000; Huber 1977); *S. cuatrecasasiana* Steyerm., *S. jahnii* (Harms) Steyerm., *S. rufa* Frodin, *S. karsteniana* (Marchal) Harms, and *S. tamana* Steyerm. Two of these five (*S. cuatrecasasiana* and *S. tamana*) are localized in their distribution and only one (*S. karsteniana*) could be considered to be widespread. Three species of *Schefflera* are found in the Cordillera de la Costa (Frodin 2008; see also Meier 1998; Steyermark & Huber 1978); *S. glabrata* (Kunth) Frodin, *S. karsteniana* (Marchal) Harms, and *S. pittieri* Harms. Two of these three have fairly wide distributions, while the third (*S. pittieri*) is known only from a few, adjacent localities in Aragua. (The Mérida record for *S. pittieri* cited by Frodin (2008) is almost certainly an error). The sole species of *Schefflera*, *S. morototoni* (Aubl.) Maguire et al., found in the Venezuelan Llanos also occurs in the Venezuelan Guayana (Frodin 2008; see also Duno de Stefano 2007).

The following new species can be added to the small number of species found in the Venezuelan Andes. We were aware that it was undescribed when we published an enumeration of the vascular plants of Guaramacal National Park (Dorr et al. 2000), but only subsequently did we collect material adequate for the description that follows.

Schefflera vanderwerffii Dorr & Stergios, sp. nov. (**Fig. 1**). Type: VENEZUELA. Trujillo: Mpio. Boconó, Parque Nacional Guaramacal, road from Boconó to Guaramacal, Laguna de Agua Negra–parte alto [sic] de la Qda. Salvaje (UTM: 1027793 N; 371576 E), 2000–2350 m, 15 Apr 2003 (fr), *B. Stergios, L.J. Dorr & R. Caracas 20271* (holotype: PORT; isotypes: K, MO, US-2 sheets, VEN).

Schefflera sp. A, Dorr et al., Contr. U.S. Natl. Herb. 40: 66. 2000 [2001].

Species nova a *Schefflera pittieri* inflorescentia congesta et styli 5 differt.

Scandent shrubs or small trees, 3–4 m tall; twigs 5–7 mm in diam., glabrescent; andromonoecious. Leaves digitately compound, (6–)7-foliolate, the leaflets in a single plane, blades narrowly ovate to ovate, chartaceous, margin hyaline and revolute, apex long acuminate, base attenuate to truncate, slightly oblique, sparingly pubescent especially along midrib and secondary veins below, glabrous above; venation brochidodromous, primary vein raised above and below, secondary veins slightly raised below, not noticeably raised above, 8–14 per side, arcuate-ascending. Petioles (10–)16.5–27 cm long, slender, terete, sparingly pubescent when young, glabrescent in age. Stipular ligules 1.8–2.4 cm long, margin entire or sparingly ciliate, apex entire or rarely slightly bifid. Median leaflets: petiolule (3.3–)4.5–7 cm long, blade 12.5–22.5 cm × 4.2–8.2 cm, apical acumen 1.5–2.8 cm long. Basal leaflets: petiolule 1–3.5 cm long, blade (7.5–)12–13.5 × (2.5–)3.7 × 5.7 cm, apical acumen 1.5–3 cm long. Inflorescence appearing subterminal, paniculate, erect, (3–) 4-branched; peduncle up to 7.5 cm long; rachis up to 5 cm long, bracts subtending rachis up to to 1 cm long; primary branches 7 to 12, 3.5–5 cm long (in fruit), bract ca. 3 mm long; secondary branches 4 to 6, 1–1.7 cm long (in fruit); ultimate inflorescence units umbellate, often with 1–2 subtending lateral umbellules; each umbellule with 4 to 6 flowers subtended by bracteoles ca. 1 mm long. Pedicels 1–2 mm long (in bud), 3–4 mm long (in fruit), pubescent to hirsute when young, glabrescent in age, not articulate. Flowers bisexual and staminate. Calyx obconic, ca. 1 mm long, with 5 minute teeth; corolla calyptrate, 3–5 × 3–4 mm, pubescent to hirsute, glabrescent in age; stamens 5, filaments ca. 0.25 mm long (in bud); anthers ca. 1.5 mm (in bud), arcuate. Styles 5, free (in bud) or very slightly connate basally (in fruit), strongly diverging in fruit and ca. 2 mm long, stigmatic surface capitate. Fruit strongly 5-ribbed when dried, urceolate, sparingly pubescent to glabrescent; pyrenes (evidently immature) 5, each 1-seeded, ca. 6 × 2.5 mm, flattened.

Distribution and ecology.—*Schefflera vanderwerffii* is known, at present, only from north- and south-facing slopes of the Ramal de Guaramacal in the northeastern corner of Guaramacal National Park where it is found in lower montane or cloud forest; 1700–2350 m.

Etymology.—The specific epithet honors Henk van der Werff of the Missouri Botanical Garden who first collected this species. Early in his career he lived in Falcón and in addition to working on the flora of that state he also made many valuable collections in the Venezuelan Andes.

Paratypes. **VENEZUELA. Portuguesa:** Mpio. Sucre, La Divisoria de la Concepción, 9°18'N, 70°06'W, 1700 m, 23 Oct 1985 (fl bud), *H. van der Werff et al. 7535* (PORT), 24 Oct 1985 (fl bud), *H. van der Werff et al. 7576* (MO, PORT).

Schefflera vanderwerffii bears a superficial resemblance to *S. pittieri*, especially with respect to the size, shape, and texture of its leaves. The new species differs from *S. pittieri*, however, in having a shorter, more congested inflorescence (ca. 10–12.5 versus 20–40 cm long), larger fruit (6 mm versus 2–3 mm long), and fewer styles (5 versus 6–8). Huber (1977: 65), in his enumeration of the woody plants of Mérida and adjacent states, considered *S. pittieri* to be a synonym of *S. quinduensis* (Kunth) Harms, but as noted by Harms (1927: 300) the two differ in the size of their flowers and the number of styles; 6–8 in the former species, 8–10 in the latter. In addition, *S. pittieri* appears to be a local endemic confined to the Cordillera de la Costa of Venezuela, while *S. quinduensis* is currently known only from the Andes of Colombia and Ecuador.

Schefflera vanderwerffii might be more closely related to *S. quinquestylorum* Steyerm., which is found in the Venezuelan Guayana (Bolívar state) and adjacent Guyana. Here, too, the size, shape, and texture of the leaves are similar as is the number of styles, and shape of the fruit (see Frodin 1997, fig. 11). *Schefflera quinquestylorum*, however, has a much longer (19–20 cm long), less divided inflorescence and the style branches in fruit are completely free from the base.

We believe that *Schefflera vanderwerfii* is andromonoecious as are many species of Araliaceae. There are clearly two floral morphs. Our description of the flowers, however, is based solely on staminate ones as among the limited flowering material available to us for analysis (two collections in bud) we found only flowers with well-developed anthers and vestigial styles and ovaries. The well-developed styles in the one fruiting collection available for our study strongly suggest that there are also bisexual flowers.

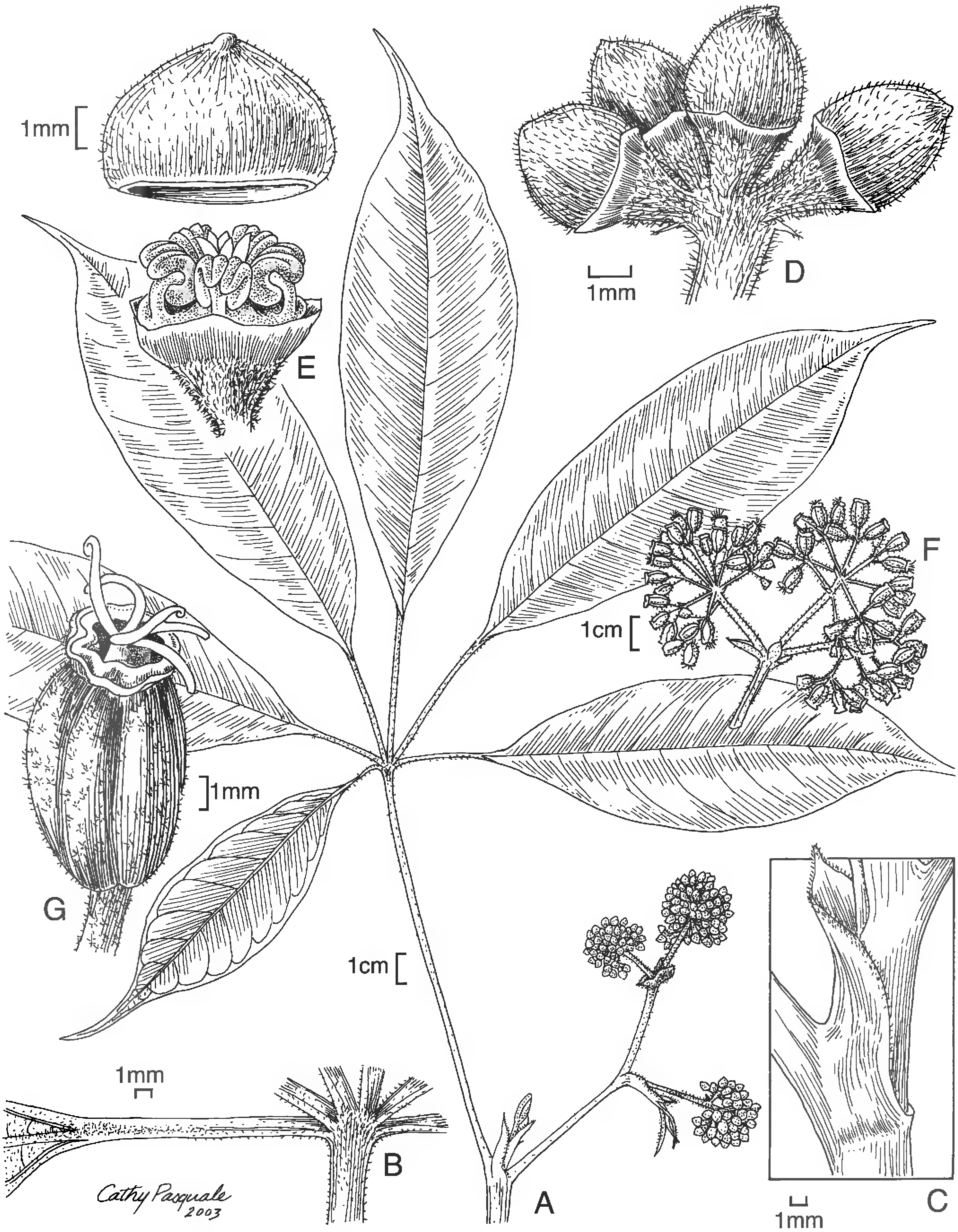


Fig. 1. *Schefflera vanderwerffii* Dorr & Stergios. **A.** Leaf and immature inflorescence. **B.** Insertion of petiolules. **C.** Stipular ligule. **D.** Immature umbel (ultimate ramification of inflorescence). **E.** Staminate flower bud with calyptrate corolla removed to show insertion of anthers and vestigial style branches. **F.** Infructescence. **G.** Fruit, showing ribs (probably an artifact of drying) and diverging style branches. (A–E, based on *van der Werff et al. 7576*, PORT; F, G, based on *Stergios et al. 20271*, US).

ACKNOWLEDGMENTS

Field work was supported by funds from the Biological Survey and Inventories Program of the National Museum of Natural History. David G. Frodin made useful suggestions regarding the affinities of this new species. Gregory M. Plunkett made helpful recommendations for improving the technical description of the same. We are indebted to the staff of Guaramacal National Park for assistance in the field, the Ministerio del Ambiente and INPARQUES for permits, and Cathy Pasquale for the illustration.

REFERENCES

BONO, G. 1996. Flora y vegetación del Estado Táchira, Venezuela. Museo Regionale di Scienze Naturali (Torino), Monografie 20:1–951.

DORR, L.J., B. STERGIOS, A.R. SMITH, AND N.L. CUELLO A. 2000 [2001]. Catalogue of the vascular plants of Guaramacal National Park, Portuguesa and Trujillo states, Venezuela. Contr. U.S. Natl. Herb. 40:1–155.

DUNO DE STEFANO, R. 2007. Araliaceae. In: R. DUNO DE STEFANO, G. AYMARD, AND O. HUBER, eds. Catálogo anotado e ilustrado de la flora vascular de los Llanos de Venezuela. FUDENA-Fundación Empresas Polar-FIBV, Caracas. Pp. 358–359.

FIASCHI, P., G.M. PLUNKETT, AND P.P. LOWRY II. 2007. What do we know about Neotropical *Schefflera* (Araliaceae)?: a first molecular phylogenetic analysis. Plant Biology & Botany 2007 Joint Congress. [Botanical Society of America, St. Louis]. P. 294.

FRODIN, D.G. 1997. Araliaceae. In: P.E. BERRY, B.K. HOLST, AND K. YATSKIEVYCH, eds. Flora of the Venezuelan Guayana 3:1–31.

FRODIN, D.G. 2008. Araliaceae. In: O. HOKCHE, P.E. BERRY, AND O. HUBER, eds. Nuevo catálogo de la flora vascular de Venezuela. Fundación Instituto Botánico de Venezuela, Caracas. Pp. 215–218.

HARMS, H. 1927. Araliaceae americanae novae. I. Repert. Spec. Nov. Regni Veg. 23:299–301.

HUBER, H. 1977. Gehölzflora der Anden von Mérida. Teil I. Mitt. Bot. Staatssamml. München 13:1–127.

MEIER, W. 1998. Flora und vegetation des Avila-Nationalparks (Venezuela/Küstenkordillere) unter besonderer Berücksichtigung der Nebelwaldstufe. Diss. Bot. 296:i–x, 1–485.

PLUNKETT, G.M., P.P. LOWRY II, D.G. FRODIN, AND J. WEN. 2005. Phylogeny and geography of *Schefflera*: pervasive polyphyly in the largest genus of Araliaceae. Ann. Missouri Bot. Gard. 92:202–224.

PLUNKETT, G.M., J. WEN, AND P.P. LOWRY II. 2004. Infrafamilial classifications and characters in Araliaceae: insights from the phylogenetic analysis of nuclear (ITS) and plastid (*trn*L-*trn*F) sequence data. Pl. Syst. Evol. 245:1–39.

STEYERMARK, J.A. AND O. HUBER. 1978. Flora del Avila. Publicación Especial de la Sociedad Venezolana de Ciencias Naturales, Caracas. Pp. 1–971.

WEN, J., G.M. PLUNKETT, A.D. MITCHELL, AND S.J. WAGSTAFF. 2001. The evolution of Araliaceae: a phylogenetic analysis based on ITS sequences of nuclear ribosomal DNA. Syst. Bot. 46:144–167.

NEW SPECIES OF *EUGENIA* (MYRTACEAE) FROM ECUADOR

Maria Lúcia Kawasaki
Department of Botany
Field Museum of Natural History
1400 South Lake Shore Drive
Chicago, Illinois 60605-2496, U.S.A.
lkawasaki@fieldmuseum.org

Bruce K. Holst
Marie Selby Botanical Gardens
811 South Palm Avenue
Sarasota, Florida 34236, U.S.A.
bholst@selby.org

ABSTRACT

Five new species of *Eugenia* (Myrtaceae) from Ecuador are described and illustrated: **Eugenia aequatoriensis, E. castaneiflora, E. crassimarginata, E. longisepala,** and **E. pusilliflora.**

RESUMEN

Se describen y se ilustran cinco especies nuevas de *Eugenia* (Myrtaceae) del Ecuador: **Eugenia aequatoriensis, E. castaneiflora, E. crassimarginata, E. longisepala** y **E. pusilliflora.**

INTRODUCTION

In the checklist of Myrtaceae of Ecuador (Holst 1999), ca. 60 species of *Eugenia* were reported; approximately 30 species represented possible new taxa and some of these have been recently described (Kawasaki & Holst 2009). In preparation of the Myrtaceae treatment for the Flora of Ecuador, five additional new species of *Eugenia* are here described: *Eugenia aequatoriensis*, *E. castaneiflora*, *E. crassimarginata*, *E. longisepala*, and *E. pusilliflora*.

Eugenia aequatoriensis M.L. Kawasaki & B.K. Holst, sp. nov. (**Fig. 1**). Type: ECUADOR. Loja: Bosque 'El Tundo', property of ARCOIRIS foundation, on track off road Sozoranga–Macará, ca. Km 1, 4°19'29.4"S, 79°49'13.9"W, 1750 m, 12 Jun 1996 (fl), *B.B. Klitgaard, B. Ståhl, P. Lozano, T. Delgado, F. Elizalde, H. Aleyandro & F. Tinitana 173* (holotype: AAU; isotypes: NY, QCA, SEL).

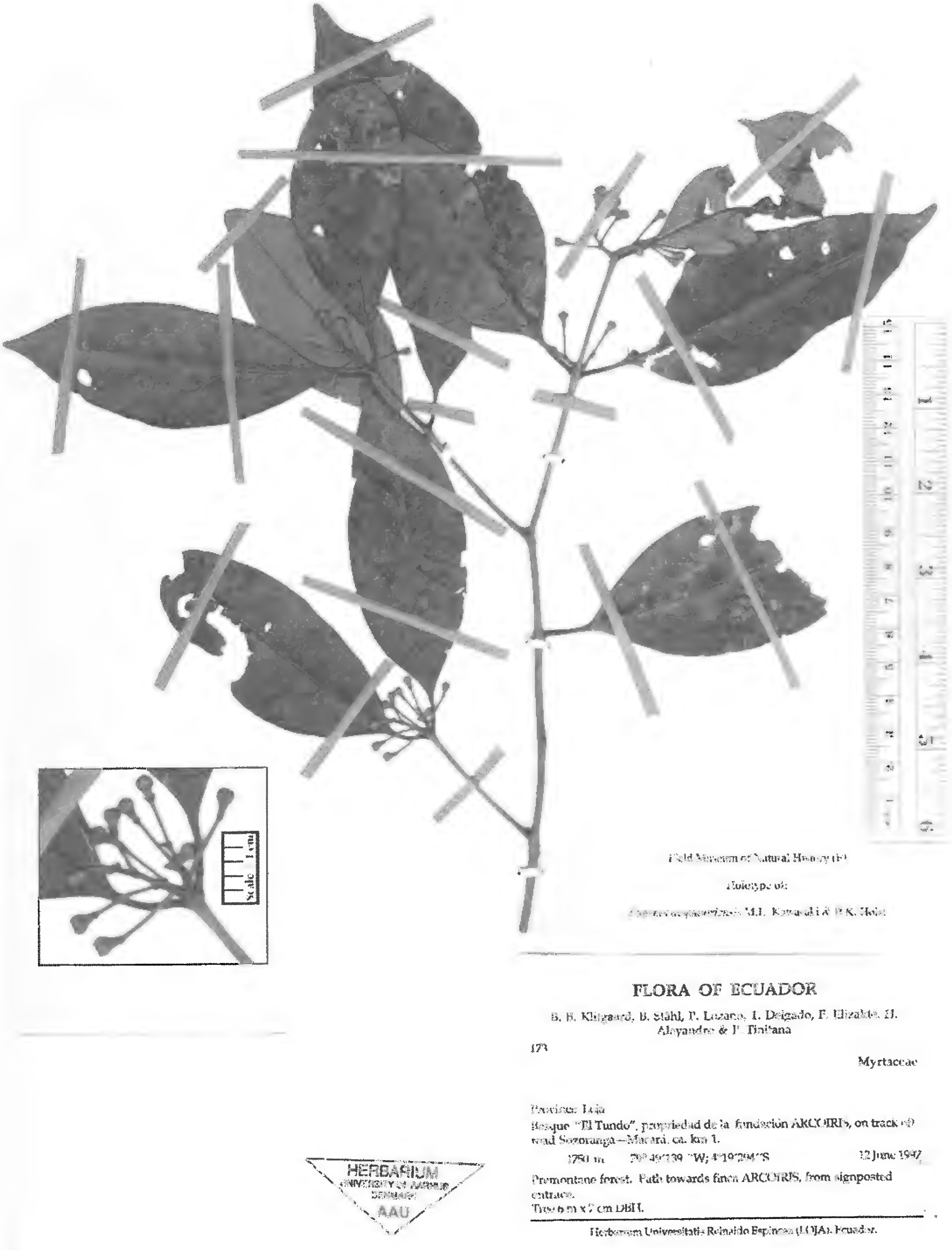
Frutex vel arbor; foliis ellipticis vel anguste ellipticis; racemis pubescentibus, indumento brunneo-rufescenti vel rubro-flavescenti, pedicellis plerumque inflorescentiis axibus longioribus; fructis ellipsoideis vel obovoideis.

Shrub or tree 3–25 m tall; trichomes, where present, brownish- or yellowish-red. **Leaf blades** elliptic to narrowly elliptic, chartaceous to coriaceous, 9–13.5 × 3–6.5 cm, mostly glabrous, drying olive-green or greenish-brown above, paler below; glands punctiform, indistinct above, dark and numerous below; midvein sulcate on the upper surface; lateral veins 10–15 pairs, indistinct or slightly convex above, convex below; marginal veins 2, the innermost slightly arched, 1–3 mm from the margin; apex acute to shortly acuminate; base cuneate; petioles 1–1.5 cm long, sulcate, glabrous. **Inflorescences** of short racemes, with up to ca. 6 flowers, axillary or subterminal, the main axis 3–13 mm long, the pedicels 4–13 mm long, appressed-pubescent; bracteoles triangular, acute, to 1 mm long, appressed-pubescent, persistent. **Flowers** 4-merous; buds 3–4 mm long; hypanthium ca. 2 mm long, appressed-pubescent; calyx lobes suborbicular, 2–3 mm long, obtuse, appressed-pubescent; petals suborbicular, ca. 4 mm diam., ciliate; disk ca. 3 mm diam., glabrous; stamens ca. 4–6 mm long; style ca. 6 mm long; ovary 2-locular, with several ovules per locule. **Fruits** berries, ellipsoid or obovoid, 1.3–1.5 × 1–1.1 cm, puberulous to glabrous, reddish; seed 1, ca. 10 × 8 mm, the seed coat membranous; embryo eugenioid, the cotyledons fleshy, connate, the radicle indistinct.

Distribution.—Known only from the region of Reserva Natural El Tundo, Sozoranga, Loja province, in wet premontane forests at 1750–1800 m elevation.

Among the species of *Eugenia* with racemose inflorescences in Ecuador, *E. aequatoriensis* is readily distinguished by the short, brownish- or yellowish-red pubescent racemes, with the main axis 3–13 mm long and a few (up to ca. 6), long-pedicellate flowers, the pedicels 4–13 mm long, often longer than the main

J. Bot. Res. Inst. Texas 3(2): 609 – 618. 2009



Field Museum of Natural History (F)
Holotype of:
Eugenia aequatoriensis M.L. Kawasaki & B.K. Holst

FLORA OF ECUADOR
B. B. Klitgaard, B. Ståhl, P. Lozano, I. Delgado, F. Elizalde, H. Alejandro & F. Tinitana
173
Myrtaceae
Province: Loja
Bosque "El Tundo", propriedad de la fundación ARCOIRIS, on track off road Sozoranga—Macará, ca. km 1.
1750 m 79°49'139 "W; 4°19'294"S 12 June 1997
Premontane forest. Path towards finca ARCOIRIS, from signposted entrace.
Tree 6 m x 7 cm DBH.
Herbarium Universitatis Reinaldo Espinosa (LOJA), Ecuador.

Fig. 1. ***Eugenia aequatoriensis*** **M.L. Kawasaki & B.K. Holst (*Klitgaard et al. 173*: Holotype, AAU).**

axis of the inflorescences. While *E. aequatoriensis* is distinct among Neotropical Myrtaceae, its affinities are not clear.

Additional collections examined: **ECUADOR. Loja:** Sozoranga, Reserva Natural El Tundo, property of ARCOIRIS foundation, Km 6 along track from Sozoranga–Macará road, 4°19'S, 79°49'W, 1800 m, 19 Aug 1997 (fr), *G.P. Lewis et al. 3492* (AAU); Sozoranga, El Tundo, Mar 1983 (fl), *F. Vivar C. et al. 1727* (AAU, LOJA).

Eugenia castaneiflora M.L. Kawasaki & B.K. Holst, sp. nov. (**Fig. 2**). TYPE: ECUADOR. MANABÍ: Pedernales, 34 km N of Pedernales along new coastal highway, near village of Chindul, 00°14'S, 79°52'W, 60 m, 28 Aug 1998 (buds), *D. Neill & QCNE botany interns 11447* (HOLOTYPE: MO; ISOTYPES: F, QCNE).

Frutex vel arbor; foliis anguste ellipticis vel oblanceolatis, 27–39 cm longis, coriaceis, glabrescentibus, acuminatis, nervo medio supra convexo vel biconvexo; floribus fasciculatis, castaneo-tomentosis; fructis ellipsoideis.

Shrub or tree 3–7 m tall, the trichomes on branchlets, petioles, and inflorescences chestnut-brown, yellowish-brown on leaf blades. **Leaf blades** narrowly elliptic or oblanceolate, coriaceous, 27–39 × 7–10 cm, drying greenish-brown or brownish, much paler below, glabrescent, the few trichomes by the midvein on the lower surface; glands punctiform, almost indistinct on both surfaces or slightly convex below; midvein convex or biconvex on the upper surface; lateral veins 20–25 pairs, convex on both surfaces; marginal veins 2, the innermost slightly arched, 2–5 mm from the margin; apex acuminate; base obtuse; petioles 1–1.5 cm long, flattened, puberulous to tomentulose. **Inflorescences** of abbreviate racemes, with up to 10 flowers, the main axis inconspicuous; flowers appearing fasciculate at leafless nodes, the pedicels 1–1.5 cm long, tomentose; bracteoles lanceolate, 2–4 mm long, tomentose, persistent. **Flowers** 4-merous; buds 9–10 mm long, tomentose; hypanthium ca. 4 mm long; calyx lobes suborbicular, 5–7 mm long, obtuse, apparently deciduous in fruit; fully developed petals, stamens, and style not seen; disk ca. 3 mm diam., glabrous; ovary 2-locular, with several ovules per locule. **Fruits** berries, ellipsoid, 3–4 × 1.5–1.8 cm, puberulous, glabrescent, gland-dotted, crowned by a tomentose collar; seeds 1(2), (1–)2.5 × (0.5–)1 cm; embryo eugenioid, the cotyledons fleshy, connate, the radicle indistinct.

Distribution.—*Eugenia castaneiflora* is known only from Manabí province, occurring in wet forests at 60–250 m elevation.

In leaf morphology and type of inflorescence, *Eugenia castaneiflora* is similar to *E. tumulescens* McVaugh, a species from northern Amazonian Brazil and southern Venezuela. In *E. castaneiflora*, however, the glands on leaves are punctiform and mostly indistinct (vs. prominently convex) on both surfaces, the petioles are smooth (vs. corky), the flowers are characteristically chestnut-brown (vs. yellowish-brown) and borne at leafless nodes (vs. axillary), the pedicels are 10–15 (vs. 8–10) mm long, and the calyx lobes are suborbicular (vs. oblong), 5–7 (vs. 6–8) mm long.

Additional collection examined: **ECUADOR. Manabí:** Pedernales Cantón, Reserva Ecológica Mache–Chindul, comunidad Ambacha (Chindul coastal highway), 250 m, 00°15'N, 79°48'W, 25 Mar 1997 (fr), *J.L. Clark et al. 4152* (F, MO, QCNE, US).

Eugenia crassimarginata M.L. Kawasaki & B.K. Holst, sp. nov. (**Fig. 3**). TYPE: ECUADOR. COTOPAXI: Tenefuerste, Río Pilalo, Km 52–53, Quevedo, Latacunga, 750–1300 m, 7 Feb 1982 (old fl), *C.H. Dodson & A.H. Gentry 12168* (HOLOTYPE: MO; ISOTYPES: SEL, US).

Arbor; foliis ellipticis, anguste ellipticis vel obovatis, chartaceis, plerumque glabris vel sparse adpresso-pubescentibus, abrupte acuminatis, crassimarginatis, venis marginalibus 4–8 mm remotis, nervo medio supra prominente; floribus fasciculatis; fructis ellipsoideis.

Tree 5–15 m tall; trichomes, where present, yellowish-white to coppery. **Leaf blades** elliptic to narrowly elliptic or obovate, chartaceous, 10–16 × 4.5–7 cm, drying olive-green, brown or dark-brown above, light greenish-brown below; upper and lower surfaces mostly glabrous to sparsely appressed-pubescent; glands punctiform, dark and convex on both surfaces; midvein convex on the upper surface; lateral veins 8–12 pairs, convex on both surfaces, but impressed on the upper surface and appearing strongly sulcate; marginal veins 2, the innermost similar to the lateral veins in prominence, slightly arched, 4–8 mm from the margin, the leaf blades appearing thick-marginate; apex abruptly acuminate, the acumen 1–2 cm long; base cuneate to obtuse; petioles 4–8 mm long, flattened, glabrous. **Inflorescences** of abbreviate racemes, with up to

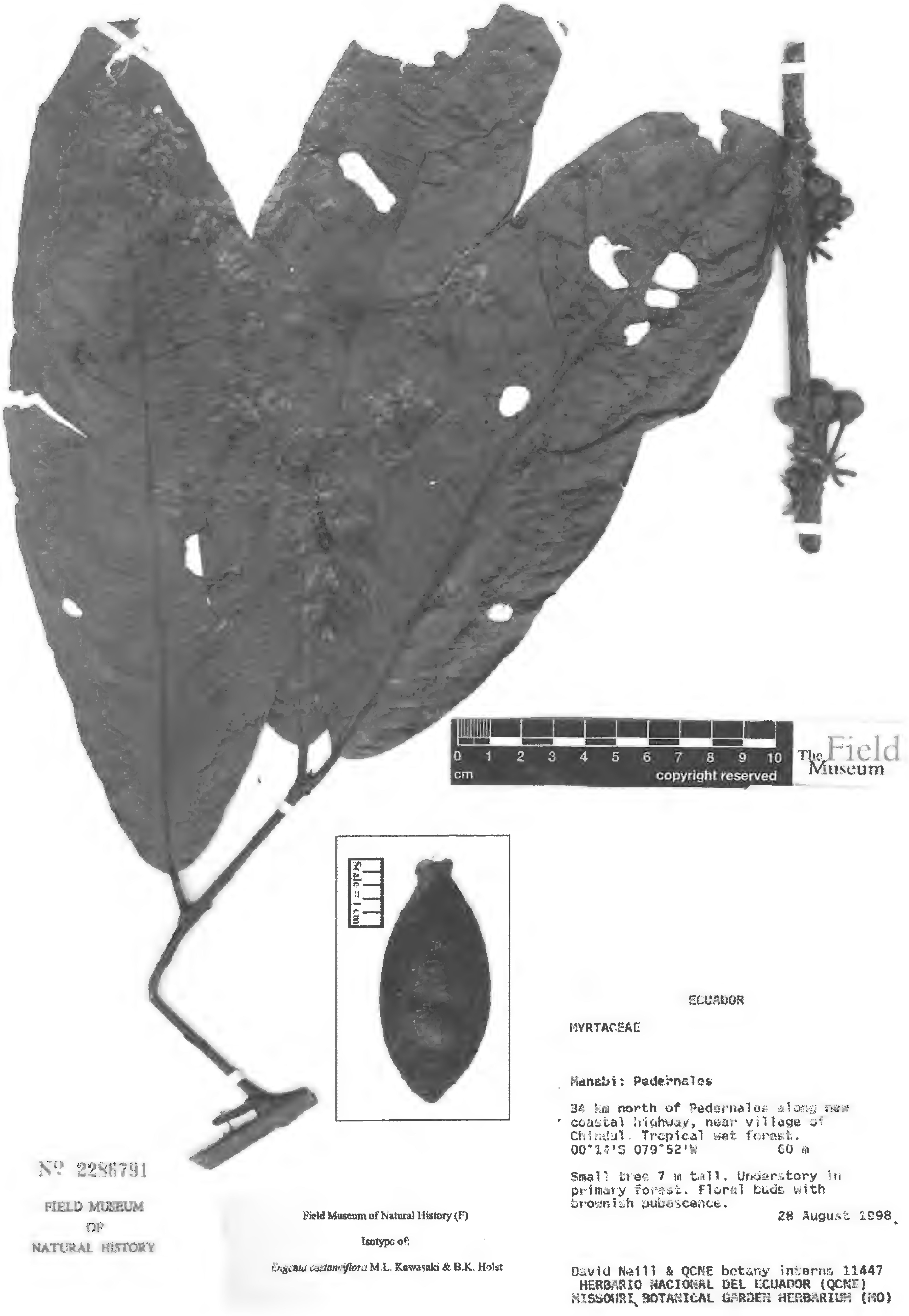

0 1 2 3 4 5 6 7 8 9 10
cm
copyright reserved
The Field Museum
Scale = 1 cm
ECUADOR
MYRTACEAE
Manabi: Pedernales
34 km north of Pedernales along new coastal highway, near village of Chindul. Tropical wet forest.
00°14'S 079°52'W 60 m
Small tree 7 m tall. Understory in primary forest. Floral buds with brownish pubescence.
28 August 1998
David Neill & QCNE botany interns 11447
HERBARIO NACIONAL DEL ECUADOR (QCNE)
MISSOURI BOTANICAL GARDEN HERBARIUM (MO)
Nº 2286791
FIELD MUSEUM
OF
NATURAL HISTORY
Field Museum of Natural History (F)
Isotype of:
Eugenia castaneiflora M.L. Kawasaki & B.K. Holst

Fig. 2. *Eugenia castaneiflora* M.L. Kawasaki & B.K. Holst (*Neill et al. 11447*: Isotype, F; fruit from *Clark et al. 4152*, F).

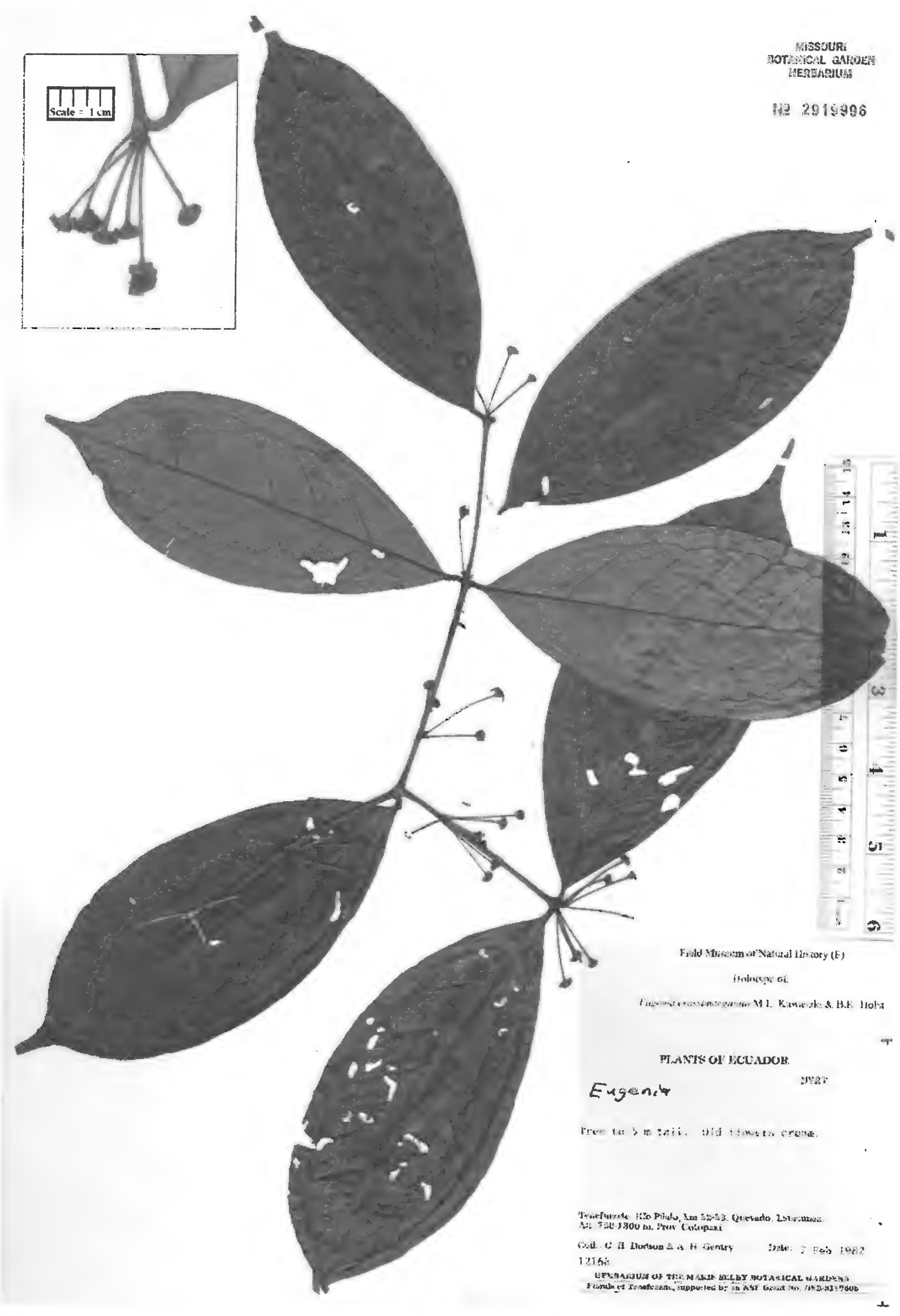

Scale = 1 cm
MISSOURI BOTANICAL GARDEN HERBARIUM
Nº 2919996
Field Museum of Natural History (F)
Holotype of:
M.L. Kawasaki & B.K. Holst
PLANTS OF ECUADOR
Eugenia
Tree to 5 m tall. Old flowers cream.
Prov. Cotopaxi
Coll. C. H. Dodson & A. H. Gentry
Date: 7 Feb 1982
12168
HERBARIUM OF THE MARIE SELBY BOTANICAL GARDENS

Fig. 3. *Eugenia crassimarginata* M.L. Kawasaki & B.K. Holst (*Dodson & Gentry 12168*: Holotype, MO; inset from isotype at SEL).

8 flowers, the main axis inconspicuous; flowers appearing fasciculate at leafless nodes, the pedicels 1–2.5 cm long, slender, appressed-puberulous to glabrous; bracteoles ovate, ca. 2 mm long, deciduous. **Flowers** 4-merous; buds not seen; hypanthium ca. 2 mm long, appressed-pubescent; calyx lobes ovate, ca. 2 mm long, obtuse, glabrous; petals not seen; disk ca. 2 mm diam., glabrous; stamens and style not seen; ovary 2-locular, with several ovules per locule. **Fruits** berries, ellipsoid, 1.5–2.5 × 1–1.5 cm, glabrous, greenish-brown, gland-dotted; seed 1, ca. 15 × 9 mm, the seed coat membranous; embryo eugenioid, the cotyledons fleshy, connate, the radicle indistinct.

Distribution.—Eugenia crassimarginata has been collected in the provinces of Cotopaxi, Los Ríos, and Pichincha, in forests at 500–1300 m elevation.

Eugenia crassimarginata is characterized by the upper surface of leaves with convex venation but immersed in the leaf blade, appearing strongly sulcate, the lateral veins joining in a continuous inner marginal vein at 4–8 mm from margin, and by the relatively small flowers borne on elongate, slender pedicels. *Eugenia churutensis* X. Cornejo, a species know only from lowland forests of Guayas province, has similar flowers and type of inflorescences, but each fascicle has 8–30 (vs. to 8) flowers, the bracteoles are narrowly triangular, 0.5–1 mm long, probably persistent (vs. ovate, ca. 2 mm long, deciduous), and the lateral veins join in irregular loops, not forming the characteristic marginal vein of *E. crassimarginata.*

Additional collections examined: **ECUADOR. Los Ríos:** Quevedo Cantón, Cerro Centinela, Montañas de Ila, 10 km E of Patricia Pilar, 00°37'S, 79°48'W, 500 m, 19 Jun 1991 (young fr), *W. Palacios & E. Freire 7452* (SEL). **Los Ríos/Pichincha:** Patricia Pilar, at 45 km on road from Santo Domingo to Quevedo, path following ridge line at El Centinela, at crest of Montañas de Ila, on road from Patricia Pilar to 24 de Mayo at Km 12, 600 m, 10 Jul 1979 (fr), *C.H. Dodson et al. 7799* (F, MO, SEL); Patricia Pilar, at 45 km on road from Santo Domingo to Quevedo, path following ridge line at El Centinela, at crest of Montañas de Ila, on road from Patricia Pilar to 24 de Mayo at Km 12, 600 m, 2 Oct 1979 (fr), *C.H. Dodson et al. 8686* (MO, SEL). **Pichincha:** Centinela, road Patricia Pilar–24 de Mayo, Km 12, ca. Km 47 of road Santo Domingo–Quevedo, at crest of Montañas de Ila, 650 m, 26 Jul 1984 (old fl/young fr), *C.H. Dodson et al. 14523* (MO, SEL).

Eugenia longisepala M.L. Kawasaki & B.K. Holst, sp. nov. (**Fig. 4**). TYPE: ECUADOR. SUCUMBÍOS: Sacha Lodge, 3 km N of the village Añangu, near the Napo river, 00°39'S, 76°26'W, 200 m, 12 Jun 1995 (fr), *J.L. Clark, L. Demattia & T. Miller 1176* (HOLOTYPE: MO; ISOTYPES: F, US).

Arbor; foliis anguste ellipticis vel lanceolatis, 23–36 cm longis, coriaceis, plerumque glabris, nervo medio supra plano vel prominente; racemis pubescentibus, indumento brunneolo vel brunneo-flavescenti, calycis lobis lanceolatis, 10–13 mm longis; fructis ellipsoideis.

Tree 7–12 m tall; trichomes, where present, brownish to yellowish-brown. **Leaf blades** narrowly elliptic to lanceolate, coriaceous, 23–36 × 7–13 cm, drying olive-green to greenish-brown above, paler below; upper surface mostly glabrous; lower surface glabrous to thinly sericeous; glands punctiform, indistinct on both surfaces or slightly convex below; midvein plane to convex on the upper surface; lateral veins 17–20 pairs, convex on both surfaces; marginal veins 2, the innermost slightly arched, 3–7 mm from the margin; apex abruptly short-acuminate; base cuneate to obtuse; petioles stout, 2–2.5 cm long, sulcate, wrinkled, sparsely tomentulose, glabrescent. **Inflorescences** of short racemes, axillary, the main axis in fruit 1–2.5 cm long, the pedicels in fruit 6–10 mm long, pubescent; bracteoles not seen, deciduous. **Flowers** (loosen) 4-merous; buds not seen; hypanthium ca. 6 mm long, pubescent; calyx lobes lanceolate, 10–13 × 5 mm long, foliaceous, acute, pubescent; petals obovate, ca. 1 cm long, glabrous; disk 3–4 mm diam., glabrous; stamens ca. 7 mm long; style ca. 7 mm long; ovary 2-locular, with several ovules per locule. **Fruits** berries, ellipsoid, 2.5–3 × 1–1.5 cm, pubescent, greenish-brown, crowned by the elongate, involute calyx lobes; seed 1, ca. 2.3 × 1 cm, the seed coat membranous; embryo eugenioid, the cotyledons fleshy, connate, the radicle indistinct.

Distribution.—Eugenia longisepala is known from the provinces of Orellana and Sucumbíos, occurring in wet forests at 200–360 m elevation.

Eugenia longisepala is similar to *Eugenia macrocalyx* (Rusby) McVaugh, a species from northern South America to Bolivia, in the uncommonly long and foliaceous calyx lobes. In *E. longisepala*, however, the inflorescences, pedicels, and flowers are stout (vs. slender), the trichomes are brownish to yellowish-brown (vs. whitish) and the leaves are much larger (23–36 × 7–13 cm vs. 6–13 × 3–5 cm), with a convex (vs. sulcate) midvein on the upper surface.

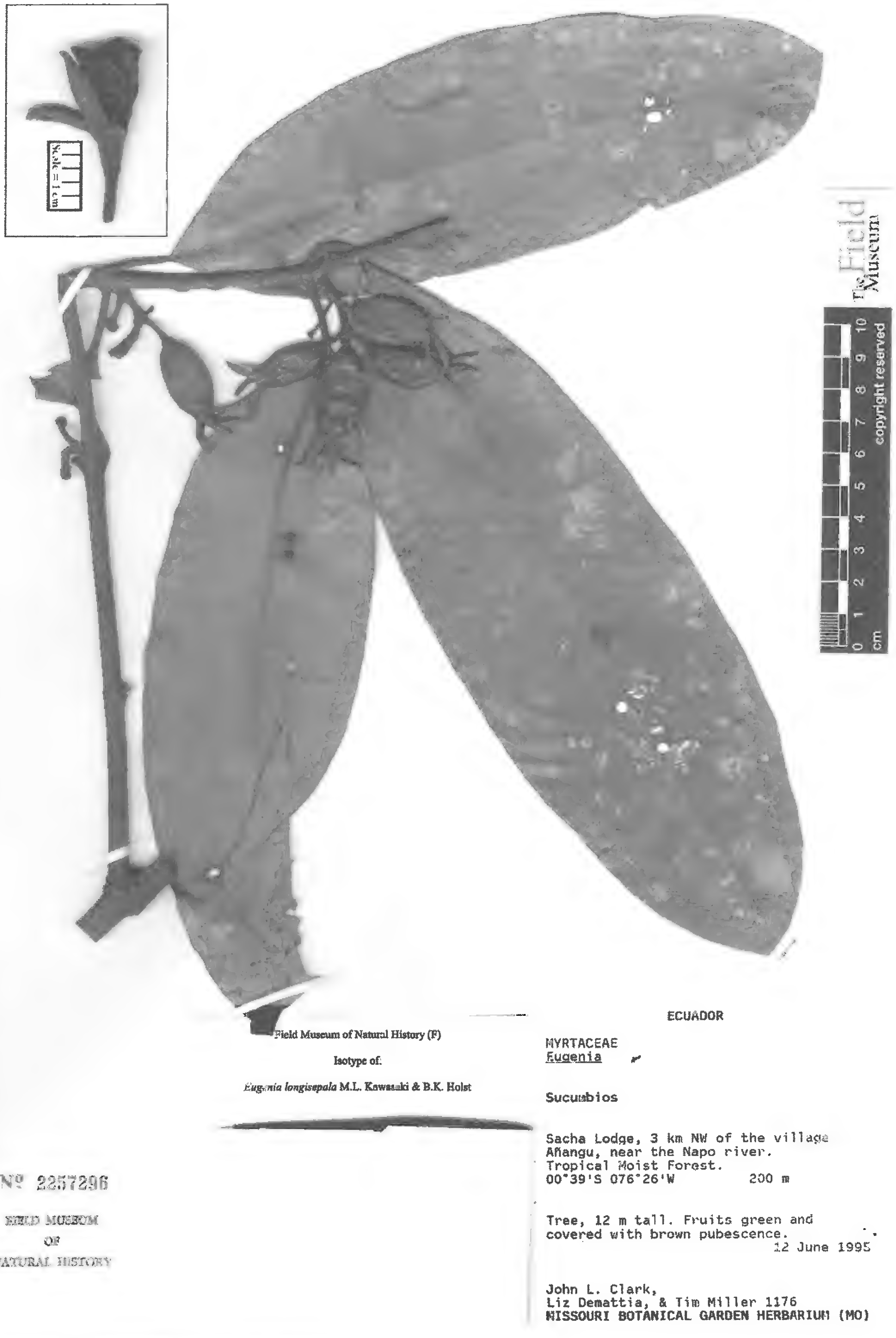

Scale = 1 cm
The Field Museum
0 1 2 3 4 5 6 7 8 9 10 cm
copyright reserved
Field Museum of Natural History (F)
Isotype of:
Eugenia longisepala M.L. Kawasaki & B.K. Holst
№ 2257296
FIELD MUSEUM OF NATURAL HISTORY
ECUADOR
MYRTACEAE
Eugenia
Sucumbios
Sacha Lodge, 3 km NW of the village Añangu, near the Napo river.
Tropical Moist Forest.
00°39'S 076°26'W 200 m
Tree, 12 m tall. Fruits green and covered with brown pubescence.
12 June 1995
John L. Clark,
Liz Demattia, & Tim Miller 1176
MISSOURI BOTANICAL GARDEN HERBARIUM (MO)

Fig. 4. *Eugenia longisepala* M.L. Kawasaki & B.K. Holst (*Clark et al. 1176*: Isotype, F; flower from *Korning & Thomsen 58651*, AAU).

Additional collections examined: **ECUADOR. Orellana:** Añangu, NW corner of the Parque Nacional Yasuní, surroundings of the SEF terra firme line and KTH hectar plot, 00°33'S, 76°22'W, 260–360 m, 1–30 Apr 1985 (fl), *J. Korning & K. Thomsen 58651* (AAU, QCA, QCNE); Estación Científica Yasuní, Río Tiputini, NW of confluence with Río Tivacuno, E of road Repsol–YPF, Km 7 on spur road to oil well Tivacuno, sendero Napo at 1400 m (left side), 00°38'S, 76°30'W, 200–300 m, 23 Jul 2002 (fr), *G. Villa & P. Alvia 1824* (AAU, QCA, US).

Eugenia pusilliflora M.L. Kawasaki & B.K. Holst, sp. nov. (**Fig. 5**). TYPE: ECUADOR. NAPO: Tena Cantón, Biological Station Jatun Sacha, 8 km E of Misahuallí, near Chinguipino stream, permanent parcel 03, 01°04'S, 77°36'W, 400 m, 16 Feb 1990 (fl), *C.E. Cerón, M. Crizón & C. Iguago 8667* (HOLOTYPE: QCNE; ISOTYPES: F, MO, SEL).

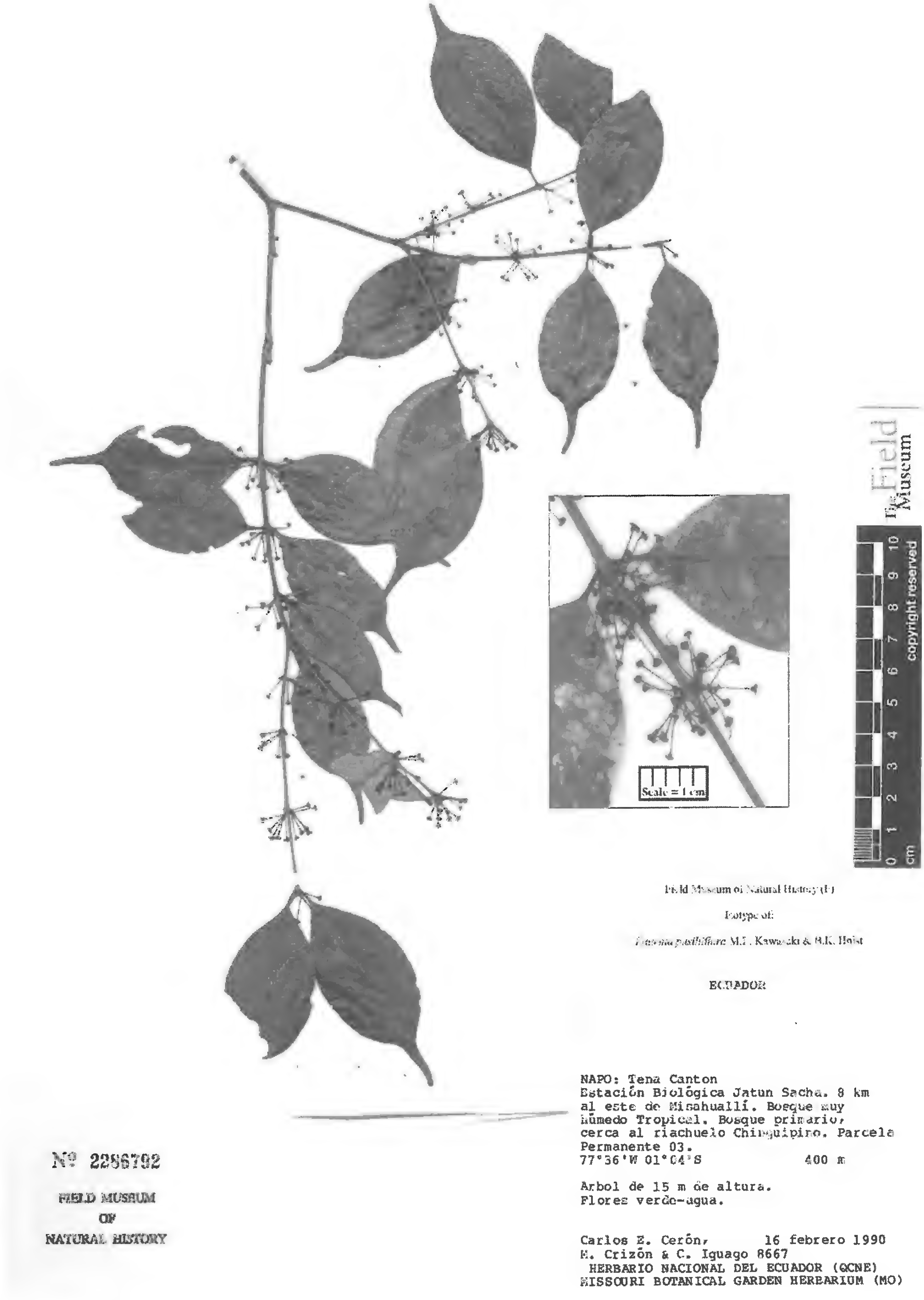
Arbor; foliis anguste ellipticis, ellipticis vel obovatis, chartaceis, puberulis, abrupte caudato-acuminatis, subtus fusco-glandulosis, nervo medio supra sulcato; racemis abbreviatis, adpresso-pubescentibus, pedicellis gracilibus, floribus pusillis; fructis globosis.

Tree 6–15 m tall; trichomes, where present, yellowish-white; branchlets smooth, puberulous, dark-dotted. **Leaf blades** narrowly elliptic to elliptic or obovate, chartaceous, 5.5–7.5 × 2–3.3 cm, drying olive-green or greenish-brown above, light yellowish-green below, puberulous on both surfaces, especially by the midvein, glabrescent; glands dark, convex on both surfaces or indistinct above; midvein sulcate on the upper surface; lateral veins ca. 10 pairs, indistinct above, slightly convex below; marginal veins 2, the innermost similar to the lateral veins in prominence, slightly arched, ca. 1 mm from the margin; apex abruptly caudate-acuminate, the acumen 1–1.5 cm long; base cuneate to obtuse; petioles 4–6 mm long, sulcate, puberulous to glabrous. **Inflorescences** of short racemes, with 4–8 flowers, axillary or subterminal, the main axis 1–4 mm long, quadrangular in cross-section, the pedicels 4–7 mm long, slender, appressed-pubescent; bracteoles ovate, to 1 mm long, appressed-puberulous, persistent. **Flowers** 4-merous; buds ca. 1.5 mm long; hypanthium ca. 1 mm long, appressed-pubescent; calyx lobes ovate, 0.4–0.8 mm long, in slightly unequal pairs, acute to obtuse, appressed-puberulous without, ciliate; petals suborbicular, ca. 2 mm diam., ciliate; disk ca. 1 mm diam., puberulous; stamens ca. 3 mm long; style ca. 3 mm long; ovary 2-locular, with several ovules per locule. **Fruits** berries, globose, 7–9 mm diam., glabrous, dark-red to purple, gland-dotted; seed 1, ca. 6–7 × 5 mm, the seed coat membranous; embryo eugenioid, the cotyledons fleshy, connate, the radicle indistinct.

Distribution.—*Eugenia pusilliflora* has been collected in the provinces of Napo, Orellana, and Pastaza, in primary rain forests at 200–430 m elevation.

Eugenia pusilliflora is characterized by the small, elliptic to obovate, abruptly caudate-acuminate leaves, dark-dotted below and with sulcate midvein on the upper surface; the inflorescences are short racemes with very small flowers and slender pedicels that are longer than the main inflorescence axis. In the shape of leaves, type of inflorescence, and size of flowers, *Eugenia pusilliflora* is similar to *E. protenta* McVaugh, a species from Venezuela and northern Brazil (Amazonas). The two species may be distinguished by these characters: the leaves of *E. pusilliflora* are puberulous (vs. glabrous), distinctly dark-dotted on the lower surface (vs. glands indistinct), chartaceous (vs. coriaceous), with sulcate midvein (vs. sulcate to plane); the axis of the inflorescences and bracteoles are yellowish-pubescent (vs. glabrous to sparsely rufous-pubescent), and the hypanthium is appressed-pubescent (vs. glabrous).

Additional collections examined: **ECUADOR. Napo:** 9 km downstream Puerto Misahuallí, 2 km S of Chinguipino river basin, 01°05'S, 77°36'W, 430 m, 10 Mar 1985 (fl), *D. Neill et al. 6063* (MO, SEL); Tena Cantón, Jatun Sacha Biological Station, 8 km E of Misahuallí, 01°04'S, 77°36'W, 400 m, 21 Sep 1990 (fr), *D. Neill 9465* (F, MO, SEL); Tena Cantón, Jatun Sacha Biological Station, S of Río Napo, 8 km E of Misahuallí, 01°04'S, 77°36'W, 400 m, 17 Sep 1992 (fr), *D. Neill & J. Zuleta 10131* (F, MO, SEL); Tena Cantón, Ahuano, 01°03'S, 77°32'W, 380 m, 10 Sep 1992 (fr), *W. Palacios et al. 10438* (F, MO, QCNE, SEL). **Orellana:** Yasuní Forest Reserve, along road between Km 70 and 100, E of PUCE Scientific Station, 00°50.014'S, 76°20.518'W to 00°50.730'S, 76°13.304'W, 200 m, 2 Jul 1995 (fr), *P. Acevedo-Rodríguez & J.A. Cedeño 7633* (SEL); Aguarico, Reserva Etnica Huaorani, Maxus road and oil well in construction, Km 102–105, 00°56'S, 76°13'W, 248 m, 24–31 Jul 1994 (fr), *A. Dik 1491* (F, MO, SEL); Aguarico, Reserva Etnica Huaorani, Maxus road and pipeline construction project, Km 99–100, 00°56'S, 76°13'W, 250 m, 9 Jul 1994 (fr), *N. Pitman 510* (SEL); Aguarico, Reserva Etnica Huaorani, Maxus road and pipeline construction project, Km 99–100, 00°56'S, 76°13'W, 250 m, 10 Jul 1994 (fr), *N. Pitman 515* (F, MO, SEL); Estación Cientifica Yasuní, Río Tiputini, NW of the confluence with Río Tivacuno, E of road Repsol-YPF, Km 7, detour to Tivacuno well, 00°38'S, 76°30'W, 200–300 m, 12 Feb 2002 (fl), *G. Villa et al. 1302* (SEL); Parque Nacional Yasuní, Río Tiputini, NW of confluence with Río Tivacuno, E of road Repsol–YPF, Km 32 to NPF, Guiyero, 00°38'S, 76°30'W, 200–300 m, 17 Jun 2002 (fr), *G. Villa et al. 1540* (F, QCA, SEL). **Pastaza:** Oil well "Golondrina", PETRO-CANADA, 30 km NW of Curaray, 01°10'S, 77°06'W, 400 m, 10 Jul 1989 (fr), *E. Gudiño 8* (F, MO, SEL).



Field Museum of Natural History (F)

Isotype of:

Eugenia pusilliflora M.L. Kawasaki & B.K. Holst

ECUADOR

NAPO: Tena Canton
Estación Biológica Jatun Sacha. 8 km
al este de Misahuallí. Bosque muy
húmedo Tropical. Bosque primario,
cerca al riachuelo Chinguipino. Parcela
Permanente 03.
77°36'W 01°04'S 400 m

Arbol de 15 m de altura.
Flores verde-agua.

Carlos E. Cerón, 16 febrero 1990
M. Crizón & C. Iguago 8667
HERBARIO NACIONAL DEL ECUADOR (QCNE)
MISSOURI BOTANICAL GARDEN HERBARIUM (MO)

Nº 2286792
FIELD MUSEUM
OF
NATURAL HISTORY

Fig. 5. *Eugenia pusilliflora* M.L. Kawasaki & B.K. Holst (*Cerón et al. 8667*: Isotype, F; inset from isotype at SEL).

ACKNOWLEDGMENTS

We thank the curators and staff of the herbaria cited in the manuscript for providing the collections used in this study, especially Henrik Balslev and Benjamin Øllgaard from AAU, and Ron Liesner and Jim Solomon from MO. We also thank Fred Barrie and Les Landrum for helpful suggestions to improve the manuscript.

REFERENCES

Holst, B.K. 1999. Myrtaceae. In: P.M. Jørgensen and S. León-Yánez, eds. Catalogue of the vascular plants of Ecuador. Monogr. Syst. Bot. Missouri Bot. Gard. 75:618–622.

Kawasaki, M.L. and B.K. Holst. 2009. Three new species of *Eugenia* (Myrtaceae) from Ecuador. Selbyana 30: 101–106.

REVISION OF *BAUHINIA* SUBGENUS *PHANERA* SECTION *SCHNELLA* (CERCIDEAE: CAESALPINIOIDEAE: FABACEAE)

Richard P. Wunderlin and Richard M. Eilers

Institute for Systematic Botany
Department of Cell Biology, Microbiology & Molecular Biology
University of South Florida
4202 East Fowler Avenue, BSF 218
Tampa, Florida 33620-5150, U.S.A.
rwunder@cas.usf.edu

ABSTRACT

A taxonomic treatment of *Bauhinia* subgenus *Phanera* section *Schnella* is presented. Eight species are recognized with **B. lilacina** Wunderlin & Eilers from Bahia, Brazil and the combination **B. trichosepala** (L.P. Queiroz) Wunderlin & Eilers as new. Keys, descriptions, and distribution data are provided.

RESUMEN

Se presenta un tratamiento taxonomico de *Bauhinia* subgénero *Phanera* sección *Schnella*. Se reconocen ocho especies con **B. lilacina** Wunderlin & Eilers de Bahia, Brasil y se hace la nueva combinación **B. trichosepala** (L.P. Queiroz) Wunderlin & Eilers. Se aportan claves, descripciones, y datos de distribución.

The pantropical genus *Bauhinia* L. (Cercideae: Caesalpinioideae: Fabaceae) with approximately 330 species consists of four subgenera: *Bauhinia* L., *Piliostigma* (Hochst.) Kurz [=*Elayuna* (Raf.) Wunderlin], *Barklya* (F. Muell.), and *Phanera* (Lour.) Wunderlin (Wunderlin et al. 1987). *Bauhinia* subgenus *Phanera*, as defined by Wunderlin et al. (1987), is a pantropical group consisting primarily of tendriled lianas in 11 sections, of which two, *Schnella* and *Caulotretus*, are confined to the New World tropics. The other nine sections are Old World. Section *Schnella* is distinguished from *Caulotretus* by its five-nerved or inconspicuously nerved calyx, an indehiscent or tardily dehiscent, thin-valved fruit, the stigma usually peltate or capitate, and the pollen sexine with conspicuous supratectal processes. In contrast, *Caulotretus* has a conspicuously 10- or 15-nerved calyx, a dehiscent, usually woody fruit, the stigma usually oblique, and the pollen sexine merely rugulose or perforate. *Bauhinia herrerae* (Britton & Rose) Standl. & Steyerm., a species placed in section *Caulotretus* by Wunderlin et al. (1987) differs in several characters which otherwise distinguish the two sections by having a peltate stigma and an indehiscent, thin-valved fruit as found in section *Schnella*, but has the distinctive calyx and pollen characters that clearly place it in section *Caulotretus*.

Recent molecular data based on ITS sequences of nuclear ribosomial DNA (Hao et al. 2003) suggests that subgenus *Phanera* is polyphyletic and that the New World *Phanera* forms a clade distinct from the rest of subgenus *Phanera* in the Old World. Recently Lewis and Forest (2005) recognized *Barklya* F. Muell., *Gigasiphon* Drake, *Lasiobema* (Korth.) Miguel, *Phanera* Lour., *Piliostigma* Hochst., and *Tylosema* (Schweinf.) Torre & Hillc. as genera distinct from *Bauhinia*. However, that classification is only partly supported by molecular data (Lewis & Forest 2005). Since further study is needed to resolve this issue, it seems best at this time to recognize *Bauhinia* s.l. rather than several segregate genera.

Two groups within section *Schnella* can be distinguished, although they are not formally recognized here. *Bauhinia lilacina*, *B. radiata*, and *B. trichosepala* differ from the others in characters of the calyx and pollen morphology. The calyx of these species is prominently 5-nerved and the pollen with the supratectal processes aligned on ridges along the colpi margins. The second group consists of *B. flexuosa*, *B. maximiliani*, *B. microstachya*, *B. poiteauana*, and *B. smilacina*. They have an inconspicuously 5-nerved calyx and the pollen with the supratectal processes subequally disposed on the tectum between the colpi and with no prominent ridges along the colpi margins.

J. Bot. Res. Inst. Texas 3(2): 619 – 628. 2009

Bauhinia L. subg. **Phanera** (Lour.) Kurz sect. **Schnella** (Raddi) Benth., in Benth. & Hook. f., Gen. Pl. 1:576. 1865. *Schnella* Raddi, Quar. Piant. Nuov. Bras. 32. 1820. *Bauhinia* section *Schnella* (Raddi) Benth. Type: *Schnella macrostachya* Raddi [=*Bauhinia radiata* Vell.]. Lectotype designated by Britton and Rose (1930).

Caulotretus Rich. ex Schott, in Sprengel, Syst. Veg. 4(2):406. 1827. *Caulotretus* sect. *Eucaulotretus* Endlicher, Gen. Pl. 1317. 1840, nom. inadmiss. Type: *Caulotretus smilacinus* Schott [=*Bauhinia smilacina* (Schott) Steud.].

Woody vines with woody, nodal tendrils. Leaves petiolate, with minute intrastipular trichomes, the blade entire or bilobate, the midrib with weak to moderately developed secondary veins, the stipules linear-lanceolate, caducous. Inflorescences terminal or subterminal and axillary, spiciform racemes, these often paniculiform through reduction of the leaves. Flowers with the hypanthium turbinate, nectariferous disc absent; calyx cupulate or campanulate, either conspicuously 5-nerved with the nerves extending beyond the lobe apex as a short mucro or as a setaceous projection, or inconspicuously 5-nerved and with the nerves not extending beyond the lobe apex, the calyx at anthesis either splitting irregularly into 2–3 lobes as the expanding petals force the calyx to rupture or expanding into 5 lobes, nectariferous; petals 5, clawed, subequal; stamens 10, free, all fertile, in two ranks with the alternate ones (inner whorl) slightly shorter, the filaments slightly upward curved, the anthers oblong, opening by longitudinal slits; pollen spheroid, 3-colporate, with the tectum granular or microrugulate, often microperforate, with spheroid supratectal processes; ovary with a short gynophore free from the hypanthium, the style terminated by a small, peltate, and asymmetric stigma. Fruit thin-valved, samaroid, indehiscent or tardily dehiscent, with the calyx persistent; seeds 1(2), with 2 short, funicular, aril-lobes.

1. Leaves of flowering or fruiting stems entire, (3–)5(–7)-nerved.
  2. Fruit narrowly elliptic (at least 4 times as long as wide), 6.5–7 cm long, chartaceous **B. smilacina**
  2. Fruit elliptic-reniform (2 times as long as wide), 3–6 cm long, subcoriaceous.
    3. Flower buds ca. 3 mm long; fruit 2.5–3.5 cm long **B. poiteauana**
    3. Flower buds 4–5 mm long; fruit 4.5–6 cm long **B. maximiliani**
1. Leaves of flowering or fruiting stems bilobate, 7- to 9-nerved.
  4. Calyx inconspicuously 5-nerved, the nerves not extending beyond the apex; flower buds 2–5 mm long.
    5. Branches conspicuously flexuous; leaves (1.5–)2.5–3.5 cm long; petals glabrous; fruit 2.5–3 cm long **B. flexuosa**
    5. Branches not flexuous; leaves (4–)7–8(–10) cm long; petals strigose along the median nerve on the outer surface; fruit 4–7 cm long **B. microstachya**
  4. Calyx conspicuously 5-nerved, the nerves extending beyond the apex as a mucro or a setaceous projection; flower buds 6–15 mm long.
    6. Petals white; leaves 9–11 cm long **B. radiata**
    6. Petals pink or lilac; leaves 4–8 cm long.
      7. Calyx nerves undulate, winged toward the apex, extending 3–5 mm beyond the apex **B. trichosepala**
      7. Calyx nerves not undulate nor winged, extending no more than 0.5 mm beyond the apex **B. lilacina**

Bauhinia flexuosa Moric., Pl. Nouv. Amer. 80, t. 53. 1840. *Schnella flexuosa* (Moric.) Walp., Repert. Bot. Syst. 5:572. 1846. *Phanera flexuosa* (Moric.) L.P. Queiroz, Neodivers. 1:6. 2006. Type: BRAZIL. Bahia: along the Rio São Francisco, Serra Açurua, 1838, *Blanchet 2853* (lectotype, here designated; selected from among three sheets at G studied by Moricand: G!; isotypes: BM!, G!, K!, NY!, P!; photo ex K: US!).

Woody, tendriled vine climbing to 5 m; young branches subterete, flexuous, strigose, becoming glabrate in age, with conspicuous lenticels, the older stems flattened. Leaves with the blade bilobed 1/8–1/3 the length, suborbicular, (1.5–)2.5–3.5 cm long, (1.5–)2–4.5 cm wide, 7-nerved, chartaceous, the lobes parallel or slightly divergent, the lobe apex rounded, the blade base rounded to cordate, the upper surface glabrous or glabrate, the lower surface sparsely strigose or hirsute, especially along the veins, glaucous, the petiole 1–1.5 cm long, loosely strigose, the stipules ovate-lanceolate, ca. 0.5 mm long, strigose. Inflorescence terminal or subterminal and axillary, in short, dense, spiciform racemes, sometimes paniculiform, 2–10 cm long, densely red-brown strigose; buds subglobose, 2–3 mm long and wide, densely red-brown strigose, the pedicel 1.5–2 mm long, the bract and bracteoles lanceolate, ca. 0.5 mm long; hypanthium depressed-cupulate, ca. 1 mm long, the inner surface glabrous; calyx cupulate, 2–3 mm long, inconspicuously 5-nerved, the nerves not extending beyond the apex, 2- to 5-lobed, the lobes triangular-ovate, the inner surface sparsely red-brown strigose; petals white, broadly spatulate, 6–7 mm long, ca. 4–5 mm wide, the claw 1–1.5 mm long, glabrous, the blade concave, the apex rounded, glabrous; stamens 3–5 mm long, the filament 3–4 mm long, glabrous, the anther oblong, ca. 1 mm long, glabrous; pollen spheroid, 3-colporate, the tectum microrugulate, often microperforate, with depressed, spheroid supratectal processes; gynoecium ca. 5 mm long, the gynophore ca. 1 mm long, red-brown short-hirsute, the ovary 2.5–3 mm long, red-brown short-hirsute, the style ca. 1.5 mm long, glabrous. Fruit elliptic-reniform, 2.5–3 cm long, 1.2–1.4 cm wide, the apex apiculate with the persistent, somewhat oblique style or style base, the valves chartaceous, reticulate, light brown or reddish brown strigose, especially on the margin, 1-seeded, the gynophore 3–4 mm long, densely red-brown strigose; seeds suborbicular to broadly reniform, ca. 9 mm long, ca. 11 mm wide, ca. 1 mm thick.

Distribution and ecology.—Brazil (Bahia and Minas Gerais). In Caatinga and seasonally dry forests at ca. 450 m. Flowering and fruiting in April.

This rare species is most closely related to *B. microstachya* but is distinguished by its smaller leaves (1.5–)2.5–3.5 cm long vs. (4–)7–8(–10) cm long), its smaller fruit (2.5–3 cm long vs. 4–7 cm long), and by its conspicuously flexuous stems.

Specimens examined: **BRAZIL. Bahia:** basin of the upper Rio São Francisco, ca. 35 km N of Bom Jesus de Lapa on the main road to Ibotirama, ca. 450 m, 19 Apr 1980, *Harley et al. 21551* (K, MEXU). **Minas Gerais:** between Inficionado and Caraça, 12 Apr 1882, *Glaziou 12622* (G, K, P); between Inficionado and Caraça, s.d., *Glaziou 13739* (P); between Inficionado and Caraça, 1883, *Glaziou 13740* (G, K, P).

Bauhinia lilacina Wunderlin & Eilers, sp. nov. (**Fig. 1**). Type: BRAZIL. Bahia: Km 5 on Núcleo Colonial de Una-São José Highway (BR 101), 4 Aug 1977, *Silva Mattos & Hage 81* (holotype: CEPEC!; isotypes: K!, US!).

Differt a *Bauhinia radiata* Vell. petalis lilacinis, florum bracteis et bracteolis triangularibus brevioribus inconspicuis, stylis dense rubrotomentosis.

Woody, tendriled vine climbing to 4 m; young branches subterete, densely red-brown tomentose, becoming sparsely so in age, with conspicuous lenticels, the older stems flattened, sometimes perforate. Leaves with the blade bilobed 1/3 the length, suborbicular, ca. 6.3 cm long, ca. 7 cm wide, 9-nerved, subcoriaceous, the lobes slightly divergent, the lobe apex rounded, the blade base cordate, the upper surface sparsely white-pilose, the lower surface red-brown tomentose, especially on the veins, the petiole ca. 2.6 cm long, red-brown tomentose, the stipules lanceolate, 2 mm long, red-brown tomentose. Inflorescence terminal or subterminal and axillary, in spiciform racemes, 10–14 cm long, red-brown tomentose; buds broadly elliptic, 6–7.5 mm long, 4–6 mm wide, red-brown tomentose, with 5 mucronate nerve tips extending ca. 0.5 mm beyond the apex, the pedicel ca. 1 mm long, the bract and bracteoles linear-lanceolate, 2–2.5 mm long; hypanthium cupulate, ca. 2 mm long, the inner surface glabrous; calyx campanulate, ca. 4 mm long, conspicuously 5-nerved, the nerves usually extending ca. 0.5 mm beyond the apex, irregularly splitting into 5 lobes, the lobes triangular, the inner surface red-brown strigose; petals lilac-colored, spatulate, 13–15 mm long, 4–6 mm wide, the claw 1 mm long, glabrous, the blade concave, the apex emarginate, with a tuft of trichomes at the apex and scattered trichomes near the base; stamens 10–12 mm long, the filament 7–9 mm long, glabrous, the anther oblong, ca. 3 mm long, glabrous; pollen spheroid, 3-colporate, the tectum microrugulate, with supratectal processes along the marginal ridges of the colpi; gynoecium ca. 11 mm long, the gynophore 1–2 mm long, densely red-brown tomentose, the ovary ca. 4.5 mm long, densely red-brown tomentose, the style 4–4.5 mm long, densely red-brown tomentose except near the stigma. Fruit not seen.

Paratype: **BRAZIL. Bahia:** without specific locality, s.d., *Belém 3675* (CEPEC!).

Etymology.—The specific epithet is in reference to the lilac-colored petals.

Distribution and ecology.—Brazil (Bahia). In secondary forest. Flowering in August.

This distinctive species is one of two species of section *Schnella* in Bahia with colored petals. It is distinguished from *B. trichosepala*, the other species with pink- or lilac-colored petals, by its smaller petals (13–15 mm long vs. 25–30 mm long), its sepals not elongated into setaceous tips, and its tomentose style.

Bauhinia maximiliani Benth., in Martius, Fl. Bras. 15(2):207. 1870. *Binaria maximiliani* (Benth.) A. Schmitz, Bull.

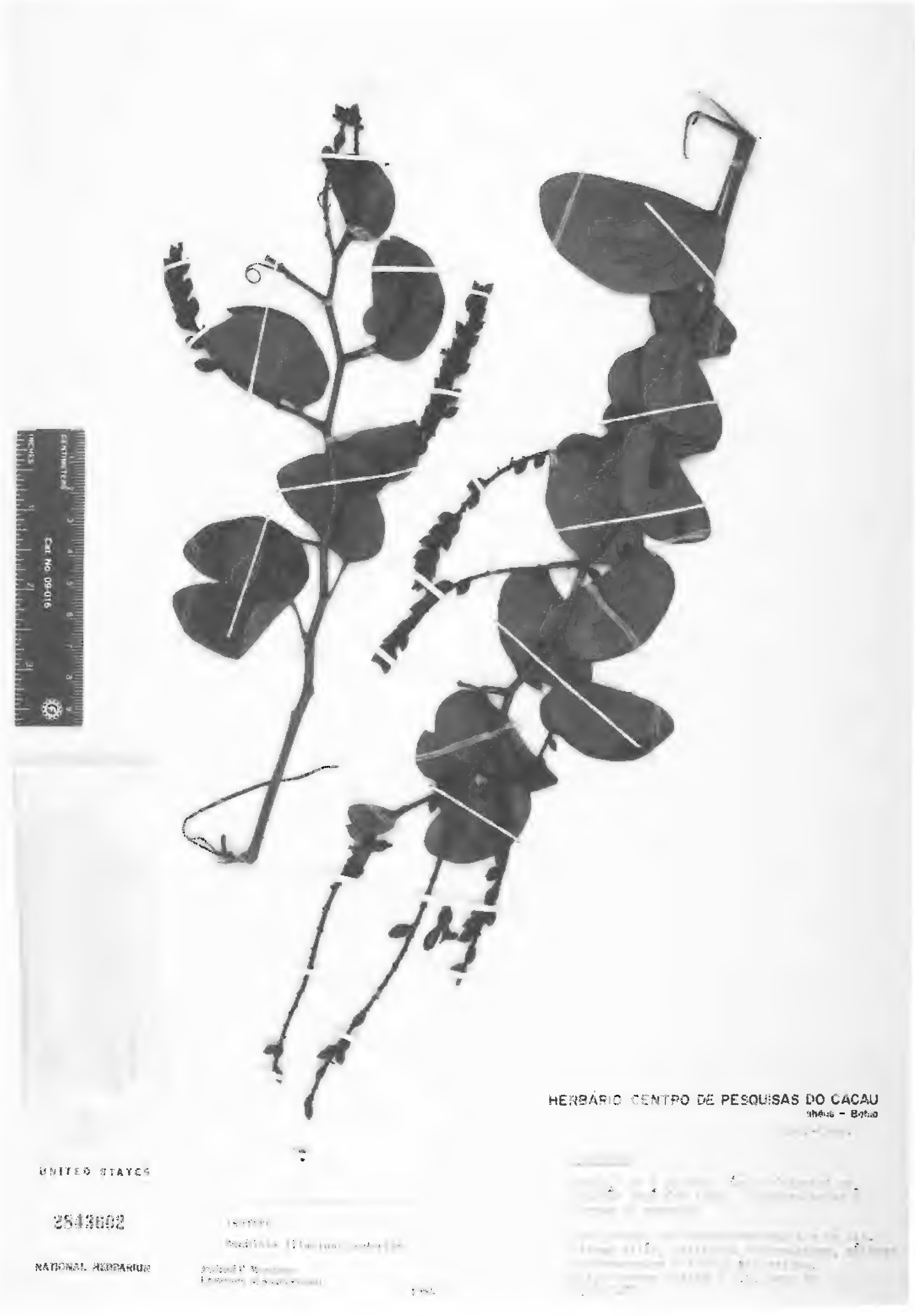

HERBÁRIO CENTRO DE PESQUISAS DO CACAU
Ilhéus – Bahia
UNITED STATES
2843602
NATIONAL HERBARIUM

Fig. 1. *Bauhinia lilicina* (isotype, US).

Jard. Bot. Natl. Belg. 43(3–4):404. 1973. Type: BRAZIL. Espírito Santo: Villa Nova de Almeida, s.d., *Wied-Neuwied s.n.* (holotype: BR; isotype: M; photo ex M: RB!).

Woody, tendriled vine; young branches subterete, red-brown strigose, soon becoming glabrate, the older stems flattened, undulate, sometimes becoming perforate. Leaves with the blade entire, elliptic to broadly lanceolate, 6–12 cm long, 3–6.5 cm wide, (3-)5-nerved, chartaceous to subcoriaceous, the apex obtuse to acuminate, the base cuneate to subcordate, the upper surface glabrous, the lower surface sparsely short-hirsute to glabrous, lighter in color than the upper surface, the petiole 0.5–1 cm long, sparsely short-hirsute or tomentellous to glabrate, the stipules ovate-lanceolate, ca. 1 mm long, tomentellous. Inflorescence terminal or subterminal and axillary, in spiciform racemes, often paniculiform, 10–25 cm long, densely red-brown strigose; buds subglobose, 4–5 mm long and wide, densely red-brown strigose, the pedicel ca. 1 mm long, the bract and bracteoles ovate-lanceolate, 0.5–1 mm long; hypanthium depressed-cupulate, ca. 1 mm long, the inner surface glabrous; calyx cupulate, 3–4 mm long, inconspicuously 5-nerved, the nerves not extending beyond the apex, (2-)3-lobed to about the middle, the lobes triangular-ovate, the inner surface sparsely brown-strigose; petals white, spatulate, 4.5–6 mm long, 3.5–4 mm wide, the claw 1–1.5 mm long, glabrous, the blade slightly concave, the apex rounded, sparsely red-brown strigose on the outer surface or glabrous; stamens 4–6 mm long, the filament 4–5 mm long, glabrous, the anther oblong, ca. 1.5 mm long, glabrous; pollen not seen; gynoecium ca. 5 mm long, the gynophore 2–3 mm long, red-brown short-hirsute to tomentose, the ovary 2.5–3.5 mm long, red-brown, short-hirsute, the style ca. 1.5 mm long, glabrous. Fruit (immature ?) elliptic-reniform, 4.5–6 cm long, 3.5–4.5 cm wide, the apex apiculate with the persistent, oblique, style base, the valves subcoriaceous, inconspicuously reticulate, red-brown strigose, 1-seeded, the gynophore 4–7 mm long, red-brown strigose; seeds not seen.

Distribution and ecology.—BRAZIL (Rio de Janeiro, Bahia, and Espírito Santo). In wet forest. Fruiting in June and July.

Originally described from flowering material and presently represented by only a few mainly fructiferous specimens, *B. maximiliani* is still poorly known. It resembles *B. poiteauana* and *B. smilacina* by its entire leaves and small, white flowers. It differs from *B. poiteauana* by its larger fruit (4.5–6 vs. 3.5–4.5 cm long), though similarly reniform, and from *B. smilacina* by its distinctive reniform fruit (vs. narrowly elliptic in *B. smilacina*). Fruiting material from Rio de Janeiro reported as *B. smilacina* by Vaz (1989) is placed here.

Specimens examined: **BRAZIL. Bahia:** along highway from Camacan to Itabuna, 29 Jul 1965, *Belém 1409* (CEPEC, IAN, NY, US); Rio Gongogi Basin, 100–500 m, 1 Oct–30 Nov 1915, *Curran 174* (US); between Camaça and Itabuna, 29 Jul 1965, *Lanna Sobriho 972* (US); along road between São José da Capelinha and Una, at Km 17 on BR 101, ca. 45 km S of Itabuna, 2 Jun 1979, *Mori 11897* (CEPEC, K, US); between Una and Rio Branco, 16 Jun 1971, *Pinheiro 1363* (CEPEC, K, US); Km 27 on São José highway (junction of BR 101), Una, near Fazenda Piedade, 20 Jul 1981, *Silva et al. 1296* (CEPEC, K). **Rio de Janeiro:** Serra da Estrella, 2 May 1880, *Glaziou 11912* (G, K, P).

Bauhinia microstachya (Raddi) J.F. Macbr., Contr. Gray Herb. 59:22. 1919. *Schnella microstachya* Raddi, Mem. Mat. Fis. Soc. Ital. Sci. Modena, Pt. Mem. Fis. 18:418. 1820. *Phanera microstachya* (Raddi) L.P. Queiroz, Neodivers. 1:6. 2006. Type: BRAZIL. Rio de Janeiro: *Raddi s.n.* (holotype: FI).

Bauhina tomentosa Vell., Fl. Flumin. 171. 1829 («1825»); non L., 1753. Type: BRAZIL. Rio de Janeiro: [lectotype, here designated: Vellozo, Fl. Flumin., Icon. 4:t. 84. 1831 («1827»)].

Bauhinia langsdorffiana Bong., Mém. Acad. Imp. Sci. St.-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt. Sci. Nat. 4:109. 1838. Type: BRAZIL. Rio de Janeiro: near Maje, 1823, *Riedel s.n.* (holotype: LE; isotypes: G!, P!).

Bauhinia bahiensis Bong., Mém. Acad. Imp. Sci. St.-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt. Sci. Nat. 4:114. 1838. *Bauhinia langsdorffiana* var. *bahiensis* (Bong.) Benth., in Martius, Fl. Bras. 15(2):204. 1870. *Bauhinia microstachya* (Raddi) J.F. Macbr. var. *bahiensis* (Bong.) J.F. Macbr., Contr. Gray Herb. 59:22. 1919. *Schnella microstachya* Raddi var. *bahiensis* (Bong.) A. Schmitz, Bull. Jard. Bot. Natl. Belg. 43:402. 1973. Type: BRAZIL. Bahia: (LECB?).

Bauhinia spicata Vogel, Linnaea 13:310. 1839; non Rottler ex Sprengel, 1807; nec König ex Wallich, 1831. *Bauhinia vogeliana* Steud., Nomencl. Bot., ed. 2. 1:192. 1840. *Schnella spicata* A. Schmitz, Bull. Jard. Bot. Natl. Belg. 43:402. 1973, nom. illegit. Type: BRAZIL: *Sello s.n.* (holotype: B, destroyed; lectotype, here designated: K!; isotypes: G!, P!; photo ex B: US!; photo ex K: US!).

Bauhinia polyantha Vogel, Linnaea 13:310. 1839. Type: BRAZIL. Rio de Janeiro: near Rio de Janeiro, s.d., *Richard s.n.* (holotype: B, destroyed).

Bauhinia lagesiana Harms, Verh. Bot. Vereins Prov. Brandenburg 48:165. 1907. Type: BRAZIL. Amazonas: near Juruá, May 1901, *Ule 5481* (holotype: B, destroyed).

Bauhinia gentlei Lundell, Wrightia 3:120. 1965. Type: BELIZE. Toledo District: between Condemn Branch Pine Ridge and Moffredye Lagoon, in cohune ridge, 15 Sep 1946, *Gentle 6047* (holotype: LL!; isotype: MO!).

Bauhinia microstachya (Raddi) J.F. Macbr. var. *massambabensis* Vaz, Pesquisas, Bot. 44:100. 1993. Type: BRAZIL. Rio de Janeiro: Massambaba, 18 Jun 1987, *M. Gomes 201* (holotype: RB).

Woody, tendriled vine climbing to 20 m or more; young branches subterete, densely red-brown strigose, soon becoming glabrous, with somewhat conspicuous lenticels, the older branches flattened, with the center undulate and sometimes perforate. Leaves with the blade bilobed 1/8–7/8 the length, suborbicular to ovate, (4–)7–8(–10) cm long, (4.6–)5–6(8) cm wide, 9-nerved, chartaceous to coriaceous, the lobes parallel to widely divergent, the lobe apex rounded, acute, or acuminate, the blade base cordate to rounded, the upper surface with a few scattered white to tan trichomes or glabrous, the lower surface red-brown tomentose, especially when young, the petiole (0.8–)1–3(–5.8) cm long, red-brown tomentose, the stipules lanceolate, ca. 3 mm long, red-brown tomentose. Inflorescence terminal or subterminal and axillary, in dense, spiciform racemes, often paniculiform, 10–23 cm long, densely red-brown tomentose; buds subglobose, slightly asymmetric, ca. 5 mm long and wide, red-brown tomentose, the pedicel ca. 0.5 mm long, the bract and bracteoles triangular, ca. 1 mm long, ca. 0.5 mm wide; hypanthium shallowly cupulate, ca. 1 mm long, the inner surface glabrous or with a few trichomes at the base of the gynophore; calyx campanulate, ca. 5 mm long, inconspicuously 5-nerved, the nerves not extending beyond the apex, (2)3-lobed, the lobes triangular, the inner surface with short, appressed trichomes; petals white, spatulate, 5–7 mm long, 2.5–4 mm wide, the claw ca. 2 mm long, red-brown strigose, the blade slightly concave, the apex rounded to obtuse, usually red-brown strigose along the median nerve on the outer surface,; stamens 7–10 mm long, the filament 6–8 mm long, glabrous, the anther oblong, ca. 2 mm long, glabrous; pollen spheroid, 3-colporate, the tectum microrugulate, often microperforate, with spheroid, supratectal processes; gynoecium 4.5–5 mm long, the gynophore to ca. 0.5 mm long, sparsely red-brown tomentose, the ovary ca. 2 mm long, densely red-brown tomentose, the style ca. 2 mm long, sparsely red-brown tomentose. Fruit elongate-reniform, (4–)5–7 cm long, 1.1–1.8 cm wide, the apex and base acute to rounded, the valves chartaceous, conspicuously reticulate, sparsely to densely red-brown or sometimes red-tomentose, particularly on the margins, 1(2)-seeded, the gynophore 2–5 mm long, red-brown strigose; seeds elliptic-reniform, 18–20 mm long, 8–10 mm wide, ca. 1 mm thick.

Distribution and ecology.—Mexico, Guatemala, Belize, Panama, Venezuela, Bolivia, Peru, Paraguay, and Brazil. In wet to moist high forest at 0–1,200 m. Flowering March to September; fruiting January to November.

Although several segregates at the species or varietal level have been proposed by previous workers, *B. microstachya* is treated here as a single, wide-ranging, polymorphic species. It is most closely related to *B. flexuosa* of the caatinga of Bahia and Minas Gerais, Brazil, but is distinguished from that species by its larger leaves (4–9 cm long vs. 1.5–3.5 cm long), its larger fruit ((4–)7–8(10) cm long vs. 2.5–3 cm long), and its lack of conspicuously flexuous stems.

Representative specimens examined. **MEXICO. Chiapas:** Lacanja-Chansayab, road from Palenque to the mouth of Lake Lacantún, 340 m, 7 Nov 1985, *Martínez 15072* (WIS). **Oaxaxa**: Cerro Buenos Aires, W side of the Temazcal Dam (Miquel Aleman), 60 m, 6 Mar 1986, *Cortes et al. 182* (MEXU); 500 m SE of the spillway of the Temazcal Dam, 70 m, 24 Nov 1986, *Cortes et al. 573* (MEXU). **Veracruz**: along road 5.5 km E of Tebanca (5.5 km E of east side of Lago Catemaco), 800 m, 5 Jul 1980, *Nee & Hansen 18853* (F, USF). **GUATEMALA. El Petén:** Km 72 of Poptun-Santa Elena Road, in high forest, 24 Oct 1966, *Contreras 6495* (US). **PANAMA. Darién:** Río Cerro Yaviza, near Yaviza, near sea level, s.d., *Duke & Bristan 422* (MO, NY, US). **VENEZUELA. Amazonas:** Río Ocamo area, between the Yanomani, 5 Oct 1978, *Fuentes 1103* (US). **Miranda:** Cerros del Bachiller, near east end, between Quebrada Corozal and Quebrada Santa Cruz, S of Santa Cruz, 18–20 m, 18–19 Mar 1978, *Steyermark & Davidse 116484* (MO, USF). **PERU. Loreto:** Florída, Río Putumayo, at mouth of Río Zubineta, ca. 200 m, Mar–Apr 1931, *Klug 2067* (BM, K, US). **Madre de Dios:** edge of Cocha Cashu, ox-bow lake of Río Manu, Parque Nacional del Manu, 12 Aug 1973, *Foster 2571* (K, US). **San Martín:** Chazuta, Río Huallaga, ca. 260 m, Apr 1935, *Klug 4060* (BM, US). **BRAZIL. Amazonas:** along the Rio Amazon, mouth of the Rio Solimões, May 1851, *Spruce 1522* (G, K, P). **Bahia:** ca. 28 km N of Seabra, road to Agua de Rega, ca. 1,000 m, 27 Feb 1971, *Irwin et al. 31164* (K, US). **Espírito Santo:** Refúgio Biológico Sooretama, 9–10 Aug 1965, *Lanna Sobriho 4598* (USF). **Minas Gerais:** State Agricultural School, Viçosa, 6 Nov 1958, *Irwin 2029* (NY). **Paraná:** Rio do Cedro, 7 Mar 1968, *Hatschbach 18664* (US, USF). **Rio de Janeiro:** Jurujuba, 19 Nov 1873, *Glaziou 6841* (K, P). **Santa Catarina:** Pinheiral, S of São Miguel d'Oeste, 600–700 m, 23 Feb 1957, *Smith & Klein 11715* (G, K, P, US). **BOLIVIA. La Paz:** Guanay, ca. 600 m, May 1886, *Rusby 952* (BM, K, US). **PARAGUAY. San Pedro:** in region of the Río Alto Paraná, 1909–1910, *Fiebrig 6201* (G, K, US).

Bauhinia poiteauana Vogel, Linnaea 13:309. 1839. Type: French Guiana. 1844, *Poiteau s.n.* (holotype: B, destroyed; lectotype, here designated: K!; photo ex B: US!; photo ex K: US!).

Woody, tendriled vine climbing to 25 m; young branches subterete, red-brown strigose or puberulent, soon becoming glabrate, with “ conspicuous lenticels, the older stems flattened, undulate, sometimes becoming perforate with age. Leaves with the blade entire, elliptic to broadly lanceolate, 8–12 cm long, 3.5–6 cm wide, 3- to 5-nerved, subcoriaceous, the apex acuminate, the base rounded to subcordate, the upper surface glabrous, the lower surface with scattered erect or appressed trichomes, the petiole 7–10 mm long, red-brown tomentellous, the stipules ovate, ca. 1 mm long, red-brown tomentellous. Inflorescence terminal or subterminal and axillary, in spiciform racemes, sometimes paniculiform, 11–12(–25) cm long, red-brown tomentellous; buds subglobose, ca. 3 mm long and wide, red-brown tomentellous, the pedicel ca. 1 mm long, the bract and bracteoles triangular-lanceolate, ca. 0.5 mm long; hypanthium depressed-cupulate, ca. 1 mm long, the inner surface sparsely appressed red-brown strigose apically; calyx campanulate, 3–4 mm long, inconspicuously 5-nerved, the nerves not extending beyond the apex, 3-lobed, the lobes triangular, the inner surface sparsely red-brown strigose; petals white, broadly spatulate, 4–6 mm long, 3–4 mm wide, the claw ca. 1 mm long, sparsely red-brown strigose on the inner surface, the blade concave, the apex rounded, sparsely red-brown pilose on the outer surface near the apex and on the inner surface near the base; stamens 6–8 mm long, the filament 5–6 mm long, glabrous, the anther oblong, ca. 2 mm long, glabrous; pollen spheroid, 3-colporate, the tectum microrugulate, often microperforate, with spheroid, supratectal processes; gynoecium 4–5 mm long, the gynophore to 0.5 mm long, densely red-brown hirsute, the ovary ca. 1 mm long, densely red-brown hirsute, the style 2–3 mm long, glabrous. Fruit elliptic-reniform, 2.5–3.5 cm long, 1.5–1.7 cm wide, the apex obliquely apiculate with the persistent style base, the valves subcoriaceous, inconspicuously reticulate, reddish, sparsely red-brown strigose, 1-seeded, the gynophore ca. 2 mm long, red-brown tomentose distally; seeds suborbicular, ca. 10 mm long, ca. 9 mm wide, ca. 1 mm thick.

Distribution and ecology.—French Guiana and Brazil (Amapá). In moist to wet forests at 0–200 m. Flowering October to December; fruiting in January and February.

This species is distinguished from the other entire-leaved species, *B. maximiliani* and *B. smilacina*, by its smaller fruits.

Specimens examined. **FRENCH GUIANA.** Cayenne, s.d., *Martin s.n.* (BM, K, P); Approuague, along the bank upstream on the Crique Tortue, 25 Jan 1967, *Oldeman 2320* (US); Camopi River, between Roche Habillée des Dames and Saut Chien, 5 Dec 1967, *Oldeman 2547* (P, US); bank of the Camopi River (tributary of l'Oyapock River), near Saut Tampac, 6 Dec 1967, *Oldeman 2567* (US); bank of the Crique Inipi 3 km from the Camopi River, 7 Feb 1968, *Oldeman & Sastre 71* (US); Cayenne, s.d., *Perrottet s.n.* (P). Without precise locality: 1838, *Leprieur 348* (P); s.d., *Leprieur s.n.* (P); 1820, *Perrottet 188* (G); 1821, *Perrottet 196* (G). **BRAZIL. Amapá:** along the Rio Oiapoque, 4 Feb 1950, *Frões 25839* (P); upper slopes and summit of Mt. Tipac, 200–250 m, 15 Oct 1960, *Irwin 48740* (K, US).

Bauhinia radiata Vell., Fl. Flumin. 170; 4: pl. 81. 1829 (“1825”). Type: BRAZIL: (lost).

Bauhinia acuminata Vell., Fl. Flumin. 171. 1829 (“1825”); non L., 1753. Type: BRAZIL. Rio de Janeiro: Rio Taguaí (lost).

Bauhinia raddiana Bong., Mém. Acad. Imp. Sci. St.-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt. Sci. Nat. 4:111. 1838. Type: BRAZIL (LECB?).

Schnella macrostachya Raddi, Mem. Reale Accad. Sci. Modena 18: Fis. 411. 1820. Type: BRAZIL: without precise location: s.d., *Raddi s.n.* (holotype: FI; isotype: G!).

Bauhinia verrucosa Vogel, Linnaea 13:311. 1839. Type: BRAZIL. Rio de Janeiro: between Rio de Janeiro and Cabo Frio, *Sello s.n.* (holotype: B, destroyed).

Bauhinia raddiana Bong. var. *brachystachya* Benth., in Martius, Fl. Bras. 15(2):203. 1870. *Schnella macrostachya* Raddi var. *brachystachya* (Benth.) A. Schmitz, Bull. Jard. Bot. Natl. Belg. 43:402. 1973. Type: BRAZIL. Rio de Janeiro: base of Monte Corcovado, May 1839, *Guillemin 706* (holotype: K!; isotypes: G!, P!)

Bauhinia leiopetala Benth., in Martius, Fl. Bras. 15(2):209. 1870. *Binaria leiopetala* (Benth.) A. Schmitz, Bull. Jard. Bot. Natl. Belg. 43:406. 1973. Type: BRAZIL. Minas Gerais: near Lagoa Santa on the Rio das Velhas, s.d., *Warming [301]* (holotype: K; isotype: P!).

Woody, tendriled vine climbing to 8 m; young branches subterete, densely red-brown tomentose, becoming glabrate in age, with conspicuous lenticels, the older stems flattened and sometimes perforate. Leaves with the blade bilobed 1/4 to 1/2 the length, suborbicular, (8.1–)9–11 cm long, (6.6–)8–11 cm wide, 7- to 9-nerved, subcoriaceous, the lobes divergent, the lobe apex rounded, the blade base shallowly cordate, the upper surface sparsely white-pilose, the lower surface short red-brown tomentose, especially on veins, usually glaucous, the petiole 2–6 cm long, red-brown tomentose, becoming glabrate with age, the stipules lanceolate to ovate, ca. 2 mm, red-brown tomentose. Inflorescence terminal or subterminal and axillary, in dense spiciform racemes, sometimes paniculiform, 8–15 cm long, red-brown tomentose; buds ovate, ca. 6 mm long, ca. 4 mm wide, red-brown tomentose, with 5 mucronate nerve tips extending ca. 0.5 mm beyond the apex, the pedicel ca. 1.5 mm long, the bract lanceolate, ca. 2 mm long, the bracteoles triangular-lanceolate, ca. 1 mm long; hypanthium cupulate, ca. 2 mm long, the inner surface sparsely red-brown tomentose near the base of the gynophore; calyx campanulate, ca. 4 mm long, strongly 5-nerved, the nerves extending 0.5–1 mm beyond the apex, conspicuously 5-lobed, the lobes triangular, the inner surface red-brown tomentose; petals white, broadly spatulate, 10–11 mm long, 4–5 mm wide, the claw ca. 3 mm long, glabrous, the blade concave, the apex emarginate, with short, red-brown trichomes along the top margin; stamens 12–13 mm long, the filament 10–11 mm long, glabrous, the anther oblong, ca. 2 mm long, glabrous; pollen spheroid, 3-colporate, the tectum microrugulate, with supratectal processes along the marginal ridges of the colpi; gynoecium 10–12 mm long, the gynophore ca. 2 mm long, red-brown appressed short-hirsute on the distal 1/2, the ovary ca. 4 mm long, appressed, short-hirsute, the style ca. 6 mm long, red-brown short-hirsute predominantly along the distal, ventral margin and the base. Fruit subelliptic, 6–10 cm long, 3.5–3.8 cm wide, slightly asymmetric, the apex acute with the oblique persistent style or style base, the valves coriaceous, conspicuously reticulate, glabrous or with a few appressed, red-brown trichomes near the gynophore, 1(–2)-seeded, the gynophore 1.5–2 cm long, appressed red-brown hirsute toward the base; seeds suborbicular, 8–12 mm long and wide, 0.5–1 mm thick.

Distribution and ecology.—Brazil (Minas Gerais and Rio de Janeiro). In moist forests at 0–700 m. Flowering in April and May.

This species is most closely related to *B. lilacina* and *B. trichosepala* from which it is easily distinguished by its white petals.

Specimens examined. **BRAZIL. Minas Gerais:** Viçosa, Agricultural College Lands, Campo Alegre, Alto de Samambaia, 685 m, 30 May 1930, *Mexia 4772* (BM, G, P, US, WIS). **Rio de Janeiro:** Rio de Janeiro, 1849, *Armstrong s.n.* (K); Jun 1767, *Commerson 201* (P); Rio de Janeiro, 1867, *Cunningham s.n.* (K); Estado do Guanabara, Morro de D. Marta, 4 Apr 1961, *Duarte 5532* (K); s.d., *Endlicher s.n.* (P); Larangeiros, near Cosme Velho, 20 Apr 1867, *Glaziou 1144* (P); s.d., *Glaziou 3720* (K, P); Corcovado, 6 May 1873, *Glaziou 6513* (G, K, P); Rio de Janeiro, s.d., *Graham s.n.* (K); s.d., *Lelande s.n.* (P); s.d., *Lépine s.n.* (P); s.d., *Loefgren 1263* (P); Rio de Janeiro, s.d., *Miers 3113* (K); Rio de Janeiro, s.d., *Miers 3536* (K); Corcovado, s.d., *Miers 4645* (K); s.d., *Nadeaud s.n.* (P); Rio de Janeiro, May 1832, *Riedel s.n.* (G); 1816–1821, *Saint-Hilaire 804* (P); 1836, *Vauthier 81* (K, P); 1836, *Vauthier 149* (G, P); s.d., *Vauthier s.n.* (P); 1844, *Widgren s.n.* (US).

Bauhinia smilacina (Schott) Steud., Nomencl. Bot. ed. 2, 1:192. 1840. *Caulotretus smilacinus* Schott, in Sprengel, Syst. Veg. 16. 4(2):406. 1827. *Schnella smilacina* (Schott) G. Don, Gen. Hist. 2:459. 1832. Type: BRAZIL. Rio de Janeiro: s.d. (fl), *Schott 5632* (lectotype, here designated: W!; isotype: US!).

Woody, tendriled vine; young branches subterete, strigose, soon becoming glabrate, with “ conspicuous lenticels, the older stems flattened, undulate, and sometimes perforate. Leaves with the blade entire, narrowly ovate to lanceolate, 5–8 cm long, 2.5–3.5 cm long, (3–)5(–7)-nerved, chartaceous to subcoriaceous, the apex acuminate to mucronate, rarely obtuse, the base subtruncate to rounded, the upper surface glabrous, slightly rugose, the lower surface with a few appressed trichomes toward the base, otherwise glabrous, slightly lighter in color than the upper surface, the petiole 7–15(20) mm long, with a few appressed trichomes or glabrous, the stipules obovate, ca. 1 mm long, glabrate. Inflorescence terminal or subterminal and axillary, in spiciform racemes, 3–10 cm long, red-brown strigose; buds elliptic-globose, ca. 3 cm long, ca. 2.5 cm wide, red-brown tomentose, the pedicel ca. 1 mm long the bract and bracteoles triangular-ovate, ca. 0.5 mm long; hypanthium depressed-cupulate, ca. 1 mm long, the inner surface sparsely red-brown pilose; calyx campanulate, 3–3.5 mm long, inconspicuously 5-nerved, the nerves not extending beyond the apex, 3-lobed, the lobes triangular, the inner surface sparsely red-brown strigose; petals white, spatulate, 6–7 mm long, 2–3 mm wide, glabrous, the claw 1–2 mm long, the blade concave, the apex rounded; stamens 5–7 mm long, the filament 4.5–5.5 mm long, glabrous, the anther oblong, 1.5–2 mm long, glabrous; pollen spheroid, 3-colporate, tectum microrugulate, often microperforate, with depressed, spheroid supratectal processes; gynoecium 4–6 mm long, the gynophore ca. 1 mm long, red-brown short-hirsute on the upper part, the ovary ca. 1.5 mm long, red-brown short-hirsute, the style ca. 4 mm long, glabrous or with a few scattered, appressed, red-brown trichomes. Fruit narrowly elliptic, 6.5–7 cm long, ca. 1.5 cm wide, slightly curved, the apex with an oblique, persistent style base, the valves chartaceous, inconspicuously reticulate, sparsely appressed, red-brown short-hirsute, 1-seeded, the gynophore ca. 7 mm long, red-brown hirsute; seeds 15–16 mm long, 9–10 mm wide, 0.5–1 mm thick.

Distribution and ecology.—Brazil (Espírito Santo and Rio de Janeiro). In wet forest. Fruiting in August.

This species differs from the other two entire-leaved species, *B. poiteauana* and *B. maximiliani*, by its narrowly elliptic, chartaceous fruit which more closely resembles that of *B. microstachya*, to which it is apparently closely related. The fruits of *B. poiteauana* and *B. maximiliani* are reniform or elliptic-reniform and subcoriaceous.

Specimens examined. **BRAZIL. Espírito Santo:** Reserva Florestal de Sooretama, 10 Aug 1965, *Belém 1537* (CEPEC, NY); Linhares, Refúgio Biológico Sooretama, 9–10 Aug 1965, *Lanna Sobo 1056* (US, USF). **Rio de Janeiro:** near Rio de Janeiro, s.d., *Burchell 1343* (K); near Rio de Janeiro, s.d., *Burchell 1565* (K). Without precise locality: s.d., *Endlicher s.n.* (P); s.d., *Glaziou 2554* (K, P); s.d., *Luschnath s.n.* (P).

Bauhinia trichosepela (L.P. Queiroz) Wunderlin & Eilers, comb. nov. Basionym: *Phanera trichosepala* L.P. Queiroz, Neodivers. 1:7. 2006. Type: BRAZIL. Bahia. Ruy Barbosa, Serra do Orobó, trilha para o Pátio das Orquídeas, 12E 18"S, 40E 29"W, 8 Feb 2005, *D. Cardoso 281* (holotype: HUEFS; isotypes: CEPEC, K).

Woody, tendriled vine; young branches subterete, red-brown tomentose, glabrate in age, with “ conspicuous lenticels, the older stems flattened, undulate, often perforate. Leaves with the blade bilobed 1/3 to 1/2 the length, suborbicular, often broader than long, 4–8 cm long, 5–10 cm wide, 7- to 9-nerved, coriaceous, the lobes slightly divergent, the lobe apex rounded, the blade base deeply cordate, the upper surface usually tomentellous on the midvein and the pulvinus, otherwise glabrous, rugose, the lower surface red-brown tomentellous, especially on the nerves, subglaucous, the petiole 1–3.5 cm long, red-brown tomentose, the stipules linear, ca. 8 mm long, red-brown tomentellous. Inflorescence terminal or subterminal and axillary, in spiciform racemes, 15–20 cm long, red-brown tomentose; buds elliptic-ovate, 1–1.5 cm long, ca. 1 cm wide, red-brown tomentose, 5-angled toward the base, undulate-winged toward the apex, each wing ending in a twisted, setaceous tip 3–5 mm long, the pedicel 2–3 mm long, the bract and bracteoles linear, 8–10 mm long; hypanthium cupulate, 2–3 mm long, the inner surface glabrous; calyx campanulate, 8–9 mm long, conspicuously 5-nerved, irregularly splitting to half the length into 2 lobes, the lobes triangular, the inner surface red-brown strigose; petals bright pink, spatulate, 2.5–3 cm long, 0.7–1.4 cm wide, the claw ca. 5 mm long, glabrous, the blade elliptic-ovate, the apex rounded, the margin slightly crisped, red-brown tomentellous toward the apex on the outer surface; stamens 2–2.5 cm long, the filament 1.5–2 cm long, glabrous, the anther oblong, 3–4 mm long, glabrous; pollen spheroid, 3-colporate, tectum microrugulate, often microperforate, with spheroid supratectal processes on the marginal ridges of the colpi; gynoecium 22–25 mm long, the gynophore ca. 4 mm long, sparsely red-brown tomentellous distally, the ovary ca. 5 mm long, sparsely red-brown tomentellous toward the base and along the ventral margin, the style ca. 14 mm long, glabrous. Fruit (immature) elliptic, 8.5–9.5 cm long, 3–3.5 cm wide, glabrous, 1-seeded, the gynophore ca. 2.5 cm long, glabrous; mature seeds not seen.

Distribution and ecology.—Brazil (Bahia and Minais Gerais). In caatinga seasonally dry forests at 800–1,000 m. Flowering Feburary to May; fruiting April to July.

A distinctive species and one of two taxa of section *Schnella* with non-white flowers. It is distinguished from *B. lilacina*, its most closely related species, by its larger petals (25–30 mm long vs. 13–15 mm long in *B. liliacina*), its undulate winged sepals elongated into conspicuous setaceous tips, and its glabrous style.

Specimens examined. **BRAZIL. Bahia:** Encruzilhada, margin of the Rio Pardo, 23 May 1968, *Belém 3598* (CEPEC); Ibotirama, 14 Apr 1971, *dos Santos 1592* (CEPEC); KM 20 on highway from Conquista to Barra do Choça, 19 Feb 1973, *dos Santos 2576* (CEPEC); 27 km SE of Morro do Chapéu on highway BA052 to Mundo Novo, ca. 800 m, 4 Mar 1977, *Harley et al. 19397* (K, US). **Minas Gerais:** Serra da Alegria, near Caraças, s.d., *Glaziou 14623* (K, P).

ACKNOWLEDGMENTS

This paper is based in part on an unpublished masters thesis completed at the University of South Florida in 1991 by the junior author. We thank the curators of BM, BR, CEPEC, F, G, IAN, K, M, MO, P, US, USF, and WIS for loan of the specimens used in this study, and Bruce F. Hansen (USF) for his insightful comments and suggestions which greatly added to this work. We also thank Rafael Torres Colín (MEXU) for his comments on the manuscript and information on collections at MEXU and an anonymous reviewer.

REFERENCES

Britton, N.L. and J.N. Rose. 1930. Caesalpiniaceae. N. Amer. Fl. 23:201–349.

Hao, G., D.X. Zhang, M.Y. Zhang, L.X. Guo, and S.J. Li. 2003. Phylogenetics of *Bauhinia* subgenus *Phanera* (Leguminosae: Caesalpinioideae) based on ITS sequences of nuclear ribosomal DNA. Bot. Bull. Acad. Sci. 44:223–228.

Lewis, G.P. and F. Forest. 2005. Tribe Cercideae. In: G. Lewis, B. Schrire, B. Mackinder, and M. Lock. Legumes of the world. The Royal Botanical Garden, Kew. Pp. 57–67.

Vaz, A.M.S. da F. and H.C. de Lima. 1986. *Bauhinia smilacina* (Schott) Steudel (Leg. Caes.)–uma espécie pouco conhecida do Etado do Rio de Janeiro. Atas Soc. Bot. Brasil, Secc. Rio de Janeiro 3:69–75.

Wunderlin, R.P., K. Larsen, and S.S. Larsen. 1987. Reorganization of the Cercideae (Fabaceae: Caesalpinioideae). Biol. Skr. 28:1–40.

REVISION OF *BAUHINIA* SUBGENUS *BAUHINIA* SECTION *PAULETIA* SERIES *ARIARIA* (CERCIDEAE: CAESALPINIOIDEAE: FABACEAE)

Richard P. Wunderlin

Institute for Systematic Botany
Department of Cell Biology, Microbiology & Molecular Biology
University of South Florida
4202 East Fowler Avenue, BSF 218
Tampa, Florida 33620-5150, U.S.A.
rwunder@cas.usf.edu

ABSTRACT

A taxonomic treatment of *Bauhinia* subgenus *Bauhinia* section *Pauletia* series *Ariaria* is presented. Seven species are recognized with **Bauhinia esmeraldasensis** Wunderlin of Ecuador described. Keys and distributional data are provided.

RESUMEN

Se presenta un tratamiento taxonómico de *Bauhinia* subgenero *Bauhinia* sección *Pauletia* serie *Ariaria*. Se reconoce siete especies con la descripción de **Bauhinia esmeraldasensis** Wunderlin del Ecuador. Se incluyen claves y datos de distribución.

The pantropical genus *Bauhinia* Linnaeus, with approximately 350 species, consists of four subgenera: *Bauhinia*, *Piliostigma* (Hochst.) Kurz [=*Elayuna* (Raf.) Wunderlin et al.], *Barklya* (F. Muell.) Wunderlin et al., and *Phanera* (Lour.) Kurz (Wunderlin et al. 1987). *Bauhinia* subgenus *Bauhinia*, as defined by Wunderlin et al., consists of nine sections of which three (*Bauhinia*, *Pauletia* (Cav.) DC., and *Amaria* (S. Mutis) Endl. are New World. A revision of section *Amaria* was recently published by Wunderlin (2006).

Section *Pauletia*, the largest section of the genus in the neotropics, as defined here, consists of five series (*Aculeatae* Vaz & A.M.G Azevedo, *Cansenia* (Raf.) Wunderlin et al., *Perlebia* (Mart.) Wunderlin et al., *Pentandra* Wunderlin et al., and *Ariaria* (C. Cuervo Márquez) Wunderlin et al.), all New World. Series *Acuminatae*, consisting of two Old World species and placed in *Pauletia* by Wunderlin et al. (1987), is transferred to the Old World section *Telestria*. Series *Aculeatae* was recently described by Vaz and Azevedo Tozzi (2003). This revision of series *Ariaria* is one of several proposed taxonomic treatments of the New World species of *Bauhina*.

KEY TO THE SERIES OF *BAUHINIA* SECTION *PAULETIA*

1. Plants unarmed.
    2. Leaves subtending the flower clusters much reduced or absent, inflorescence a terminal raceme or panicle, the plants never cauliflorus ____ ser. **Cansenia**
    2. Leaves subtending the flower clusters normally developed, inflorescence leaf-opposed or the plants cauliflorous ____ ser. **Ariaria**
1. Plants armed with spinescent infrastipular excrescences.
    3. Fruit indehiscent ____ ser. **Perlebia**
    3. Fruit dehiscent.
        4. Fertile stamens 5, or if 10, then the alternate ones much reduced ____ ser. **Pentandrae**
        4. Fertile stamens 10, of slightly unequal length ____ ser. **Aculeatae**

Bauhinia section **Pauletia** series **Ariaria** (C. Cuervo Márquez) Wunderlin et al., Biol. Skr. 28:13. 1987. *Ariaria* C. Cuervo Márquez, Prehist. & Viajes 219. 1893. Type: *Ariaria superba* C. Cuervo Márquez [=*Bauhinia tarapotensis* Benth.].

Unarmed trees or shrubs. Leaves bilobed; adpetiolar intrastipular excrescence enlarged, forming a laterally flattened, obtuse-tipped, lanceolate structure. Calyx at first spathaceous, soon splitting to the hypanthium into several lobes; fertile stamens 10; pollen 5–7-porate or -colpate, the sexine reticulate with infratectal processes. Fruit dehiscent.

J. Bot. Res. Inst. Texas 3(2): 629 – 637. 2009

1. Plants with cauliflorous racemes.
  2. Cauliflorous racemes to 80 cm long; fruit 20–22 cm long **B. flagelliflora**
  2. Cauliflorus racemes to 4 cm long; fruit 10–15 cm long **B. esmeraldasensis**
1. Plants with terminal or subterminal racemes along leafy branches.
  3. Leaf lobes with the apex acute or obtuse **B. tarapotensis**
  3. Leaf lobes with the apex rounded.
    4. Leaf blades ovate 5–9(–11)-nerved.
      5. Lower surface of the leaf blade with appressed trichomes **B. multinervia**
      5. Lower surface of the leaf blade with erect trichomes **B. eilertsii**
    4. Leaf blades suborbicular, 11–13-nerved.
      6. Leaf blades 8–13 cm long; ovary densely tomentose; Colombia **B. conceptionis**
      6. Leaf blades 14–24 cm long; ovary tomentulose; Ecuador **B. pichinchensis**

1. Bauhinia conceptionis Britton & Killip, Ann. New York Acad. Sci. 35:160. 1936. Type: COLOMBIA. Chocó: La Concepción, 15 km E of Quibdó, ca. 75 m, 20 Apr–23 May 1931, W.A. *Archer 2086* (holotype: NY!).

Tree to 9 m; branches minutely tomentulose soon becoming glabrate. Leaves with the blade chartaceous, suborbicular, 8–13 cm long, 10–13 cm wide, bilobed ca. 1/4 their length, the lobes slightly divaricate, the base shallowly cordate, the lobe apex rounded, the upper surface glabrous, the lower surface minutely tomentulose, at least on the nerves, slightly lighter in color than the upper surface, 11-nerved, the petiole 3.5–4 cm long, minutely tomentulose to glabrate; stipules ovate to lanceolate, 1–2 long, caducous; adpetiolar intrastipular excrescence to 2 mm long, the others minute. Inflorescence terminal or subterminal and axillary, 2–4-flowered, the flowers paired on a common peduncle, the rachis tomentulose; buds linear-lanceolate, ca. 5 cm long, obscurely 5-nerved, the apex apiculate, the peduncle 1–1.5 cm long, the pedicel 1.5–2 cm long; bracts and bracteoles lanceolate, 2–3 mm long, caducous. Hypanthium tubular, 10–13 mm long, 10-nerved; calyx at first spathaceous, soon irregularly splitting to the hypanthium into 2–5 lobes; petals white, subequal, linear to linear-spathulate, ca. 5 cm long, 6–7 mm wide, glabrous or glabrate (sometimes with a few trichomes on the claw), the margin slightly crisped, the claw ca. 1 cm long; fertile stamens 10, the filaments of the outer whorl ca. 5 cm long, subequaling the petals, the inner whorl slightly shorter, irregularly connate at the base to 5 mm into a staminal sheath, the staminal sheath tomentulose on the inner surface, the anthers not seen; gynoecium ca. 5 cm long, subequaling the androecium, the ovary ca. 1.5 cm long, densely tomentose, with sparse glandular trichomes, the stipe ca. 1.5 cm long, glabrate, the style ca. 1.5 cm long, tomentose proximally, sparsely tomentulose to glabrate distally, the stigma obliquely capitate. Fruit not seen.

Distribution and ecology.—Colombia in Chocó. Known only from the type collection. Habitat unknown. Flowering in April.

Bauhinia conceptionis is closely related to *B. tarapotensis*, but differs by its suborbicular leaves with rounded lobe apices and smaller flowers (6–7 cm long vs. 14–21 cm long in *B. tarapotensis*).

2. Bauhinia eilertsii Pulle, Recueil Trav. Bot. Néerl. 6:269. 1909. Type: SURINAME: Upper Suriname River near Dotti Bergi, 9 Jul 1908, *J. Tresling 86* (holotype: U!).

Tree to 22 m; branches hirsute-tomentulose to glabrate when young, soon becoming glabrous. Leaves with the blade chartaceous, suborbicular, 10–21 cm long, 10–21 cm wide, emarginate or bilobed to 1/3 their length, the base cordate, the lobe apex rounded, the upper surface glabrous, the lower surface light brown hirsute-tomentulose, slightly lighter in color than the upper surface, 9–11-nerved, the petiole (2.5–)4–5(–6) cm long, brown hirsute-tomentulose; stipules lanceolate, ca. 2 mm long, persistent; adpetiolar infrastipular excrescence ca. 2 mm long, the others minute. Inflorescence terminal or subterminal and axillary, the flowers paired on a common peduncle, sometimes short-racemose, rarely paniculate, or less commonly solitary by abortion, the rachis brown-tomentose; buds linear, 7–9 cm long, 10-nerved, the apex acute, the peduncle ca. 1 cm long, the pedicel 0.5–2.0 cm long; bracts and bracteoles ovate-lanceolate, ca. 1 mm long, persistent. Hypanthium short-tubular, 1.5–2.5 cm long; calyx at first spathaceous, soon irregularly splitting to the hypanthium into 2–5 lobes; petals white with wine-red veins, subequal, linear to linear-spatulate, 8–11 cm long, 6–10 mm wide, glabrous, the margins slightly crisped, the claw ca. 1 cm long; fertile stamens 10, the filaments wine-red, the outer whorl 8–11 cm long, subequaling the petals, the inner whorl slightly shorter, irregularly short-connate at the base for 5–20 mm into a staminal sheath, the staminal sheath tomentose on its inner surface, otherwise glabrous, the anthers linear-oblong, 1–1.5 cm long, glabrous; gynoecium 7–9 cm long, subequaling the androecium, the ovary 1.5–2 cm long, reddish brown-tomentose, the gynophore 3–4 cm long, reddish brown-tomentose near the ovary, glabrate below, the style 4–6 cm long, reddish brown-tomentose proximally, sparsely short-hirsute distally, the stigma obliquely capitate. Fruit linear, apiculate with the persistent style base, 20–30 cm long, 2.5–3 cm wide, reddish brown-tomentulose or -velutinous, the stipe ca. 4 cm long, glabrate; seeds oblong to suborbicular, ca. 15 mm long, ca. 12 mm wide, the surface brown, dull, the funicular aril-lobe scars subequal, ca. 1 cm long, extending ca. 1/3 the way around the seed.

Distribution and ecology.—Venezuela in Bolívar and Monagas and in Suriname. In forest at 100–800 m. Flowering January to October; fruiting January to July.

This species is most closely related to *B. multinervia*, but is easily distinguished by its erect trichomes on the lower leaf surface and the blade suborbicular (vs. appressed trichomes and the blade rarely suborbicular in *B. multinervia*).

Specimens examined. **VENEZUELA. Bolívar:** between the town of El Dorado and small settlement at km 88, along the trail connecting the La Lara and Corazon de Jesús mines, Aug 1966, *Blanco 537* (MO, NY); ca. 12 km S of El Dorado (06°43'N, 61°37'W), 19 Feb 1983, *Hokche 25* (USF); near Palmar, ca. 100 m, ca. 50 km NE of Upata, (07°39'54"N, 66°7'48"W), 19 Jun 1983, *Hokche 39* (USF); Reserva Forestal Imataca, Carretera Casa Blanca-San Martín de Turumbán (Anacoco), Río Cuyuní, 21 May 1982, *Stergios et al. 3863* (MO); along road between km 11 and 18.5, S of El Dorado, 215 m, 23 Jul 1960, *Steyermark 86620* (US). **Monagas:** ca. 2–3 km NE of Santa Ines, 790–800 m, 6 Jun 1967, *Pursell et al. 9188* (NY, US). **SURINAME.** Nature Park Brownsberg, near Irene Falls, 21 Jan 1974, *Roberts s.n.* (*L.B.N. No. 16305*) (K, US); Nature Park Brownsberg, 10 Oct 1969, *Tawjaeran s.n.* (*L.B.N. No. 12584*) (K, US); Nature Park Brownsberg, 25 Jan 1974, *Tawjoeran s.n.* (*L.B.N. No. 13721*) (K, US); Nature Park Brownsberg, 2 Jul 1924, *Wullschlaegel s n.* (*L.B.N. No. 6126*) (K); Nature Park Brownsberg, 24 Mar 1924, *Wullschlaegel s.n.* (*L.B.N. No. 6421*) (NY); Nature Park Brownsberg, 30 Jan 1925, *Wullschlaegel s.n.* (*L.B.N. NO. 6760*) (NY).

3. Bauhinia esmeraldasensis Wunderlin, sp. nov. (**Fig. 1**). TYPE: ECUADOR. ESMERALDAS: Bilsa Biological Station, Montañas de Mache, 35 km W of Quinindé, 5 km W of Santa Isabela (00°21'N, 79°44'W), 400–600 m, 3 Jan 1955, *N. Pitman 1173* (HOLOTYPE: MO!; ISOTYPE: USF!).

A *Bauhiniae flagelliflorae* Wunderlin foliis, fructibus, et inflorescentiis minoribus differt.

Tree to 6 m; branches minutely stigulose to glabrate, soon becoming glabrous. Leaves with the blade submembranaceous to chartaceous, suborbicular, 8–13 cm long, 8–13 cm wide, bilobed 1/4–1/3 their length, the lobes divaricate, the base cordate, the lobe apex acute to apiculate or slightly caudate, the upper surface glabrous, the lower surface minutely tomentulose, at least on the nerves, slightly lighter in color than the upper surface, 9–11-nerved, the petiole 4–6 cm long, minutely strigulose to glabrate; stipules lanceolate, ca. 2 mm long, caducous; adpetiolar intrastipular excrescence ca. 2 mm long, the others minute. Inflorescence cauliflorous racemes to 4 cm long, 10–12-flowered, the flowers fasciculate, the rachis tomentulose; buds linear-lanceolate, 3–4 cm long, 10-nerved, the apex acuminate, the peduncle ca. 5 mm long, the pedicel ca. 5–10 mm long; bracts and bracteoles triangular-ovate, ca. 1 mm long, persistent. Hypanthium short-tubular, 6–10 mm long, 10-nerved; calyx at first spathaceous, soon splitting to the hypanthium into 2–5 lobes; petals white, subequal, linear-spathulate, 5–7 cm long, 0.5–1 cm wide, glabrous, the margin slightly crisped, the claw ca. 5 mm long; fertile stamens 10, the filaments of the outer whorl 4–6 cm, slightly shorter than the petals, the inner whorl ca. 1 cm shorter, irregularly connate at the base 10–15 mm into a staminal sheath, the staminal sheath sparsely pilose on the inner surface, the anthers linear-oblong, glabrous, those of the inner whorl 5–6 mm long, those of the outer whorl 3–4 mm long; gynoecium 6–7 cm long, subequaling the androecium, the ovary ca. 1 cm long, tomentose, the gynophore ca. 2 cm long, glabrous, the style 3–4 cm long, tomentulose proximally, the stigma obliquely capitate. Fruit 10–15 cm long, 2–2.5 cm wide, brown, apiculate with the persistent style base, sparsely tomentulose to glabrate, 3–4-seeded, the stipe ca. 2 cm long, glabrous; seeds suborbicular, 12–14 mm long, 9–11 mm wide, the surface dull brown, the funicular aril-lobe scars 2–3 mm long.

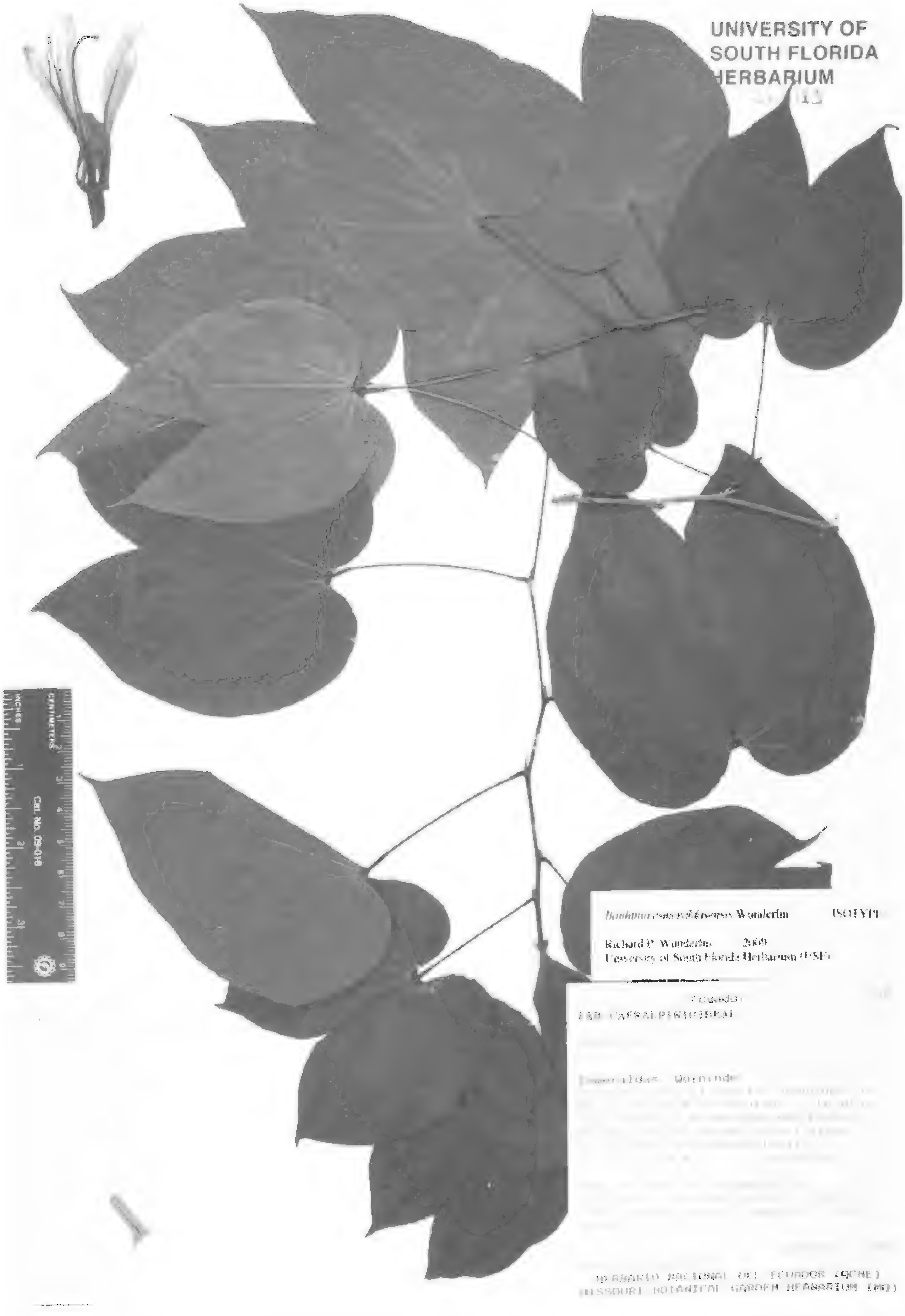

UNIVERSITY OF
SOUTH FLORIDA
HERBARIUM
CENTIMETERS
INCHES
Cat. No. 09-018
Bauhinia esmeraldasensis Wunderlin
ISOTYPE
Richard P. Wunderlin 2009
University of South Florida Herbarium (USF)
ECUADOR
FAB. CAESALPINIOIDEAE
HERBARIO NACIONAL DEL ECUADOR (QCNE)
MISSOURI BOTANICAL GARDEN HERBARIUM (MO)

Fig. 1. ***Bauhinia esmeraldasensis*** **(isotype, USF).**

Paratypes: **ECUADOR. Esmeraldas:** Bilsa Biological Station, Montañas de Mache, 35 km W of Santa Isabel, (00°21'N, 79°44'W), 400–600 m, 28 Sep 1994, *M.S. Bass, L. Kueppers, & N. Pitman 88* (MO, USF); Bilsa Biological Station, Mache Mountains, 35 km W of Quinindé, 5 km W of Santa Isabel, (00°21'N, 79°44'W), 400–600 m, 14 Nov 1994, *J.L. Clark, H. Lintz, & S. Mora 234* (MO, USF); Bilsa Biological Station, Mache Mountains, 35 km W of Quinindé, 5 km W of Santa Isabel, (00°21'N, 79°44'W), 400–600 m, 7 Oct 1994, *J.L. Clark & H. Lintz 162* (MO, USF) Bilsa Biological Station, Mache Mountains, 35 km W of Quinindé, 5 km W of Santa Isabel, (00°21'N, 79°44'W), 400–600 m, 10 Apr 1995, *J.L. Clark & Y. Troya 696* (MO, USF); Bilsa Biological Station, Montañas de Mache, 35 km W of Quinindé, 5 km W of Santa Isabela, (00°21'N, 79°44'W), 400–600 m, 7 Dec 1994, *N. Pitman & M. Bass 1039* (MO, USF).

Etymology.—The name is derived from the Ecuadorian Province Esmeraldas.

Distribution and ecology.—Endemic to Ecuador in Esmeraldas. In mature premontane wet forest at 400–600 m. Flowering January to October; fruiting September to December.

Bauhinia emeraldasensis is closely related to *B. flagelliflora* in being cauliflorous, but differs in its smaller inflorescences (4 cm long in *B. esmeraldasensis* vs. 80 cm in *B. flagelliflora*), its smaller fruit (10–15 cm long in *B. esmeraldasensis* vs. 20–22 cm in *B. flagelliflora*) and its thinner and smaller leaves (8–13 cm long in *B. esmeraldasensis* vs. 20–26 cm in *B. flagelliflora*).

In the Cercideae, cauliflory occurs in the temperate northern hemispheric genus *Cercis* Linnaeus and the African genus *Adenolobus* (Harvey) Torre & Hillcoat. It is unknown in the west African genus *Griffonia* Baillon and the Madagascaran genus *Brenieria* Humberet and is rare in *Bauhinia*. In the new world species of *Bauhinia* it is known to occur only in *B. cookii* Rose (subgenus *Bauhinia* section *Amaria*) and in two species of subgenus *Bauhinia* section *Pauletia* series *Ariaria* (*B. esmeraldasensis* and *B. flagelliflora*).

4. Bauhinia flagelliflora Wunderlin, Brittonia 35:335. 1983. Type: ECUADOR. Pichincha: ridge line at Centinela at crest of Montañas de Ila on road from Patricia Pilar to 24 de Mayo at km 12, 600 m, 6 Feb 1979, *C.H. Dodson 7345* (holotype: SEL!; isotypes: MO!, USF!).

Tree to 9 m; branches glabrous. Leaves with the blade submembranaceous to chartaceous, broadly ovate, 20–26 cm long, 17–20 cm wide, bilobed to ca. 1/4 their length, the lobes slightly divaricate, the base cordate, the apex lobe attenuate, the upper surface glabrous, the lower surface tomentulose, at least on the nerves, slightly lighter in color than the upper surface, 9–11-nerved, the petiole 7–9 cm long, sparsely tomentulose to glabrate; stipules triangular-lanceolate, ca. 2 mm long, caducous; adpetiolar intrastripular excrescence ca. 1 mm long, the others minute. Inflorescence cauliflorous racemes to 80 cm long, 20–40-flowered, the flowers paired or solitary by abortion, the peduncle adnate to the rachis (stem), emerging just above the next higher node, the rachis tomentulose; buds linear, ca. 6 cm long, ecostate, the apex apiculate, the peduncle 10–20 cm long, the pedicel ca. 1 cm long; bracts and bracteoles triangular-ovate, ca. 1 mm long, persistent. Hypanthium tubular, ca. 1.5 cm long, obscurely 10-nerved; calyx at first spathaceous, soon irregularly splitting to the hypanthium into 2–5 lobes; petals white, linear-oblanceolate, ca. 5 cm long, ca. 6 mm wide, glabrous, the claw ca. 5 mm long; fertile stamens 10, the filaments of the outer whorl 3.5–4 cm long, the inner whorl slightly shorter, irregularly short-connate at the base for 1–5 mm into a staminal sheath, the staminal sheath pilose-tomentose on the inner surface, the anthers linear-oblong, 6–8 mm long, glabrous; gynoecium ca. 6 cm long, subequaling the androecium, the ovary ca. 12 mm long, tomentose, the gynophore 2.5–3 cm long, glabrous, the style ca. 2 cm long, tomentulose proximally, otherwise glabrate, the stigma obliquely capitate. Fruit (immature) linear-oblanceolate, apiculate with the persistent style base, 20–22 cm long, 2–2.2 cm wide, brown, sparsely tomentulose to glabrate, the stipe ca. 3 cm long, glabrous; seeds not seen.

Distribution and ecology.—Ecuador in Pichincha. Known only from the type collection. In subpluvial forest at 600 m. Flowering in February.

With its large leaves, *Bauhinia flagelliflora* at first resembles *B. pichichensis* and *B. tarapotensis*, but is probably more related to *B. esmeraldasensis* by being cauliflorous, a feature it shares with that species (see above). It differs from *B. esmeraldasensis* by its larger inflorescences (80 cm long in *B. flagellliflora* vs. 4 cm long in *B. esmeraldasensis*) and its larger leaves (20–26 cm long in *B. flagelliflora* vs. 8–13 cm long in *B. esmeraldasensis*) which are also chartaceous (vs. submembranaceous in *B. esmeraldasensis*).

5. Bauhinia multinervia (Kunth) DC., Prodr. 2:515. 1825. *Pauletia multinervia* Kunth, Nov. Gen. Sp. Pl. 6:316. 1825.

Type: VENEZUELA. Miranda: Curiepe and Montaña de Capaya, 16–25 Nov 1799, *H.F.W.H.A. von Humboldt & A.J.A. Bonpland 576* (holotype: P; microfiche IDC 156/C7!; isotype: B(W); photo ex B(W): F!, G!, MO!, NY!, US!).

Pauletia glaucescens Kunth, Nov. Gen. Sp. Pl. 6:317. *Bauhinia glaucescens* (Kunth) DC., Prodr. 2:515.1825. Type: VENEZUELA. Monagas: near Caripe, 4–24 Sep 1799, *H.F.W.H.A. von Humboldt & A.J.A. Bonpland 221* (lectotype, here designated: P, microfiche IDC 157/A1!; isotype: P, microfiche IDC 157/A2!).

Bauhinia megalandra Griseb., Fl. Brit. W.I. 213. 1860. Type: ST. VINCENT: *L. Guilding s.n.* (lectotype, here designated: K!; photo ex K: F!, IJ!, US!).

Large shrub or tree to 10 m; branches ferruginous-tomentose when young, soon becoming glabrate. Leaves with the blade chartaceous, ovate, rarely suborbicular or elliptic-oblong, 7–18 cm long, 6–14 cm wide, bilobed 1/4 to 1/2 their length, the lobes slightly divaricate, the base cordate to rounded, the lobe apex rounded or obtuse, the upper surface glabrous, the lower surface minutely strigose, occasionally glaucous, ferruginous-tomentulose on the nerves and sometimes on the blade, lighter in color than the upper surface, (5–)7–9(–11)-nerved, the petiole 2–4 cm long, ferruginous-tomentose to glabrate; stipules ovate, ca. 1 mm long, persistent; adpetiolar intrastipular excrescence to 2 mm long, the others minute. Inflorescence terminal or subterminal and axillary, racemose or paniculate, 3–20-flowered, sometimes paired, the rachis ferruginous-tomentose, becoming glabrate in age, buds linear, 8–11 cm long, the apex rounded, the pedicel 1–3 cm long; bracts and bracteoles ovate, ca. 1 mm long. Hypanthium short-tubular, 2–3 cm long; calyx at first spathaceous, soon irregularly splitting to the hypanthium into 2–5 lobes; petals white, subequal, linear, 6–8 cm long, 3–6 mm wide, glabrous, the claw 6–8 mm long; fertile stamens 10, the filaments of the outer whorl 6–8 cm long, equaling or exceeding the petals, the inner whorl slightly shorter, irregularly short-connate at the base for 5–15 mm into a staminal sheath, the staminal sheath with a laciniate collar on the adaxial side, reddish tomentose at the base, the filaments sometimes tomentulose proximally to nearly their length, the anthers 1.5–2 cm long, glabrous; gynoecium 8–10 cm long, subequaling the androecium, the ovary 2–3 cm long, reddish brown-tomentose, the gynophore 4–5 cm long, reddish brown-tomentose, the style ca. 3 cm long, tomentose or tomentulose below, glabrate on the upper 1/2, greenish white, the stigma oblique-capitate. Fruit linear, apiculate with the persistent style, (15–)20–30 cm long, 2–3 cm wide, dark brown, sparsely tomentulose to glabrate, the stipe 4–6(–8) cm long, reddish brown-tomentose; seeds suborbicular or oblong, 15–18 mm long, 10–15 mm wide, the surface dull, dark brown, the funicular aril-lobe scars 12–15 mm long, extending 1/2 way around the edge of the seed.

Distribution and Ecology.—Lesser Antilles in Antiqua, Guadeloupe, Martinque, and St. Vincent, and in Venezuela, Trinidad, and Suriname. Along stream margins in deciduous forests and moist evergreen forests at 0–1,200 m. Flowering and fruiting all year. Sometimes cultivated as a novelty, but apparently not naturalizing.

Bauhinia multinervia is most closely related to *B. eilertsii*, but is easily distinquished by the appressed trichomes of the lower leaf surface (vs. erect trichomes in *B. eilertsii*).

Representative specimens examined. **ANTIQUA.** Northwest (volcanic district), Fig Tree Hill, 14 Nov 1937, *Box 1259* (BM, UC, US); without precise locality, 14–16 Feb 1913, *Rose et al. 3401* (US). **GUADELOUPE.** without precise locality, 20 m, 1839, *Beaupertuis s.n.* (P); without precise locality, 1787, *Isert s.n.* (C); without precise locality, 4 Mar 1938, *Questel 690* (US); without precise locality, s.d., *Richard s.n.* (P). **MARTINIQUE.** without precise locality, 1857, *Belanger 496* (P); without precise locality, 1882, *Duss 1124* (NY); St. Luce, 5 m, 2 Jan 1939, *Stehle & Stehle 3550* (US); without precise locality, s.d., *Terrasson 44* (P). **ST. VINCENT.** without precise locality, Mar 1890, *Smith & Smith 273* (K, NY). **VENEZUELA. Bolívar:** along road between Km 11 and 18.5, S of El Dorado, 23 Jul 1960, *Steyermark 86620* (US). **Cojedes:** near Tinaquillo, 24 Dec 1925, *Pittier 11989* (US). **Distrito Federal:** along the Río Los Caracas above town of Los Caracas, 11 Feb 1973, *Croat 21557* (MO); road to electricity plant behind Naiquetia, near sea level, 12 Mar 1974, *Gentry & Morillo 10331* (MO); along the Río Los Caracas, 0.8 m, 4 Nov 1982, *Hokche 24* (USF); along road from Country Club to Río Chacaito, Nov 1942, *Lazzer 646* (US); 1–2 km S of Los Caracas, 40 km E of La Guaira, 18 Aug 1979, *Nee 17552* (WIS). **Miranda:** along the Río Guatopo, 400–600 m, 30 Nov 1956, *Bernardi 5755* (G, MO); Parque Nacional Guatopo, near park headquarters at S entrance, 13 Feb 1973, *Croat 21729* (MO); 3 km SW of Araguita along road between Caucagua and Altigracia de Orituco, 130 m, 17 Nov 1973, *Davidse 4127* (MO); ca. 1–2 km upstream from the mouth of the Río Chiquito at its intersection with the Río Caura, S of El Gaupo, ca. 100 m, 3 Jun 1977, *Davidse & González 13600* (MO, USF, VEN); along Quebrada Chaguarama, 0–4 km SW of Palo Quemado, 6 km SE of Cúpira, ca. 50–100 m, 5 Mar 1980, *Liesner & González 9194* (MO, USF, VEN); Guinand Estate (Cardenas), Siquire Valley, 500–1,000 m, 19–24 Mar 1913, *Pittier 5982* (NY, US); Parque Nacional de Guatopo, on steep slopes bordering Santa Cruz, between Santa Teresa and Alto Garcia de Aretuco, 14.5 km from Los Alpes, 12 km from Rancheria mi Querencia, 520 m, 23 Nov 1961, *Steyermark 89949* (NY, US); Cerros del Bachiller, near E end, margins of Quebrada Corozal, S of Santa Cruz, 10 km W of Cúpira, 20–65 m, 16–17 Mar 1978, *Steyermark & Davidse 116243* (MO, USF, VEN). **Monagas:** Montaña de Aquacate, along Quebradade Pajarral, tributary to Río Caripe, NE of Alto de Aquacate, between Caripe and Caripito, 600–900 m, 19 Apr 1945, *Steyermark 62177* (F). **Sucre:** vicinity of Cristóbal Colón (Macuro), 5 Jan–22 Feb 1923, *Broadway 633* (NY, US). **Yaracuy:** Montaña de María Lionza, vicinity of Quebrada Quibayo along the Río Yaracuy, S of Chivacoa, 250–260 m, 12 Mar 1981, *Steyermark et al. 124894* (USF, VEN). **TRINIDAD.** without precise locality, Jan 1857, *Crueger s.n.* (K); without precise locality, 1877–1780, *Fendler 328* (BM, K, P). **SURINAME.** National Reserve Brownsberg, 10 Oct 1969, *Tawjoeran s.n.* (US).

6. Bauhinia pichinchensis Wunderlin, Brittonia 35:338. 1983. Type: ECUADOR. Pichincha: Cooperativa Santa Marta #2 along Río Verde 2 km SE of Santo Domingo de Los Colorados, 530 m, 5 Feb 1979, *C.H. Dodson, A.H. Gentry, and J.A. Duke 7594* (holotype: SEL!; isotypes: MO!, USF!).

Tree to 10 m; branches reddish brown-tomentulose when young, glabrate in age. Leaves with the blade chartaceous, oblong-suborbicular, 14–24 cm long, 13–21 cm wide, emarginate or bilobed to 1/4 their length, the lobes slightly divaricate, the base cordate, the lobe apex rounded, the upper surface glabrous, the lower surface reddish brown short-tomentose or -tomentulose, at least on the nerves, conspicuously reticulate-nerved, lighter in color than the upper surface, 11-nerved, the petiole 4–5 cm long, reddish brown-tomentulose; stipules lanceolate, ca. 2 mm long, deciduous; adpetiolar intrastipular excrescence to 2 mm long, the others minute. Inflorescence subterminal and axillary, short-racemose, 2–4-flowered, the flowers paired, the rachis reddish brown short-tomentose; buds linear-fusiform, ca. 5 cm long, the apex acute, obscurely 5-nerved, the peduncle ca. 1 cm long, the pedicel 2–2.5 cm long; bracts and bracteoles triangular-ovate, 1–1.5 mm long, persistent. Hypanthium short-tubular, ca. 1 cm long, 5- or obscurely 10-nerved; calyx at first spathaceous, soon irregularly splitting to the hypanthium into 2–5 lobes; petals white, subequal, linear, 4–5 cm long, 3–6 mm wide, the claw 1–1.5 cm long; fertile stamens 10, the filaments of the outer whorl 3–4 cm long, the inner whorl slightly shorter, irregularly connate at base for 1–2 mm into a staminal sheath, the staminal sheath glabrous, the anthers ca. 1 cm long, glabrous; gynoecium ca. 5 cm long, subequaling the androecium, the ovary ca. 1.5 cm long, tomentose, the gynophore ca. 1.5 cm long, glabrate, the style ca. 1 cm long, tomentulose, the stigma obliquely capitate. Fruit linear oblanceolate, apiculate with the persistent style base, 20–25 cm long, 3–3.5 cm wide, light brown, glabrate, the stipe ca. 3 cm long, glabrate; seeds 16–18 mm long, 14–16 mm wide, the surface dull brown, the funicular aril lobe scars extending about 1/2 way around the edge of the seed.

Distribution and Ecology.—Known only from Ecuador in Carchi, Esmeraldas, and Pichincha. In forest at 250–1,200 m. Flowering and fruiting all year.

First collected by Raymond Benoist in 1930, the plant was rediscovered by Calaway H. Dodson in 1979 and recognized as a new species by Wunderlin (1983). It most closely resembles *B. conceptionis* of Colombia in having large suborbicular, emarginate to slightly bilobed leaves, but differs from that species by having larger leaves (14–24 cm long in *B. pichinchensis* vs. 8–13 cm long in *B. conceptionis*) and the ovary tomentulose (vs. densely tomentose in *B. conceptionis*). *Bauhinia conceptionis* is related more closely to *B. tarapotensis* than to *B. pichinchinensis*.

Specimens examined. **ECUADOR. Carchi:** Reserva Indígena Awá, San Marcos, 25 km NW of El Chical (01°02'N, 78°14'W), 1,800 m, 15–28 Jun 1991, *Rubio et al. 943* (MO, USF); Reserva Indígena Awá, Gualpi Alta (01°02'N, 78°14'W), 1,800 m, 15–28 Jun 1991, *Rubio et al.* 1730 (MO, USF). **Esmeraldas:** Reserva Ethnica Awá, Centro de La Unión, Cañón del Río Mira (00°52'N, 78°26'W), 250 m, 22 Mar 1993, *Aulestia & Aulestia 1467* (MO, USF); road from Lita to San Lorenzo, 10 km N of Lita, 11 May 1987, *Acevedo & Daly 1684* (NY, USF); Reserva Ethnica Awá, Centro Pambilar (01°08'N, 78°36'W), 500 m, 21 Jan 1993, *Aulestia & Aulestia 1052* (MO, USF); Reserva Indígena Awá, Cañón del Río Mira, 10 km E of Alto Tambo (01°02'N, 78°26'W), 250 m, 16–26 Mar 1991, *Rubio et al. 1141* (MO, USF). **Pichincha:** Santo Pas, Charco Vicente, Río San Miguel (00°43'N, 78°53'W), 200 m, 20–31 Sep 1993, *Tirado et al. 394* (MO, USF); Santo Domingo de Las Colorados, 8 Sep 1930, *Benoist 3043* (US); Cooperativa Santa Marta #2 at km 3 W of bypass round Santo Domingo de Las Colorados, 530 m, 22 Jul 1979, *Dodson et al. 8541* (MO, SEL, USF); Centinela, 12 km E of Patricia Pilar at Km 45 between Santo Domingo de Las Colorados, 600 m, 2 Feb 1985, *Dodson & Neil 15525* (MO, USF).

7. Bauhinia tarapotensis Benth. in Mart., Fl. Bras. 15(2):198. 1870. Type: PERU. San Martín: near Tarapoto, 1855–1856, *R. Spruce 4417* (holotype: K!; isotypes: B-destroyed, BM!, K!, F!, G!, P!; photo ex K (holotype): F!; photo ex B: F!, MO!; photo ex G: F!, MO!).

Ariaria superba C. Cuervo Márquez, Prehist. & Viajes 219. 1893. Type: PERU. Loreto: near mouth of Río Santiago, 200 m, 25 Nov 1931, *Y. Mexia 6158* (neotype: F!; isoneotypes: BM!, G!, K!, MO!, WIS!). Neotype here designated. No specimens were cited in the protolog. The name was overlooked until Forero (1966) concluded that it was a synonym of *B. tarapotensis* Benth.

Bauhinia baina J.F. Macbr., Field Mus. Nat. Hist., Bot. Ser. 13(3):211. 1943. Type: PERU. Loreto: Río Mazán, 10 May 1929, *Ll. Williams 186* (holotype: F!; isotype: US!). Macbride gives the locality in the protolog as ARío Mazán@ and no date. The handwritten label on the holotype says ARio Masana@ (presumably Río Mazán), and the date 10 May 1929. The printed label with the specimens states Aalong Río Itaya@ AMay, 1929@.

Bauhinia amplifolia Ducke, Bol. Tecn. Inst. Agron. N. 2:16. 1944. Type: BRAZIL. Amazonas: near Tabatinga, margin of the Paraná de Aramassa, 4 Mar 1944, *A. Ducke 1594* (holotype: IAN; isotypes: F!, MO!, US!).

Large shrub or tree to 10(19) m; branches strigulose to tomentulose, soon becoming glabrate. Leaves with the blade chartaceous, ovate, 10–20(–25) cm long, 7–15 cm wide, bilobed 1/4–1/2 their length, the lobes slightly divaricate, the base rounded to cordate, the lobe apex acute to obtuse, the upper surface glabrous, the lower surface minutely strigose, often reddish brown-tomentulose toward the base and on the nerves, slightly lighter in color than the upper surface, 9–11-nerved, the petiole 2.5–4(–6) cm long, tomentulose to glabrate; stipules ovate to lanceolate, ca. 2 mm long, caducous; adpetiolar intrastipular excrescence to 3 mm long, the others minute. Inflorescence terminal or subterminal and axillary, 2–20-flowered, the flowers paired, the rachis strigose to tomentose; buds linear, 11–13(–18) cm long, the apex acute, obscurely 5-nerved, the peduncle ca. 5 cm long, the pedicel 5–10 mm long; bracts and bracteoles lanceolate, 2–3 mm long, persistent. Hypanthium long-tubular, 4–6 cm long, 10-nerved; calyx at first spathaceous, soon irregularly splitting to the hypanthium lip into 2–5 lobes; petals white, subequal, glabrous or glabrate, linear-filiform to -spathulate, 9–15 cm long, 3–10(–25) mm wide, the margin crisped, the claw 1.5–2 cm long; fertile stamens 10, the filaments of the outer whorl 7–13 cm long, the inner whorl slightly shorter, occasionally with 2 reduced, irregularly connate at the base for 7–18 mm into a staminal sheath, the staminal sheath glabrous or tomentulose on the inner surface, the anthers linear, 10–17 mm long; gynoecium 8–13 cm long, subequaling the androecium, the ovary 2–3 cm long, with glandular trichomes or rarely tomentulose to tomentose, the gynophore 6–10 cm long, glabrous, the style 4–6 cm long, glabrous, the stigma obliquely capitate. Fruit linear, apiculate with the persistent style base, brown, 15–25 cm long, 2.5–3.5 cm wide, the stipe 4–5 cm long, glabrous; seeds elliptic-obovate to suborbicular, 15–20 mm long, 11–18 mm wide, the surface dull, brown, the funicular aril-lobe scars ca.1.5 cm long, extending 1/3–1/2 the way around seed.

Distribution and ecology.—Colombia in Caqueta, Meta, and Putumayo; Ecuador in Napo, Morona-Santiago, and Pastaza; Peru in Amazonas, Huánuco, Loreto, San Martín, and Ucayali; Brazil in Acre and Amazonas. In high primary or secondary rainforest, usually along rivers at 90–1,000 m. Flowering and fruiting all year.

Bauhinia tarapotensis is closely related to *B. conceptionis*, a species restricted to Colombia, but differs in having ovate leaves (vs. suborbicular in *B. conceptionis*) with acute to obtuse lobes apices (vs. rounded in *B. conceptionis*) and larger flowers (14–21 cm long in *B. tarapotensis* vs. 6–7 cm long in *B. conceptionis*).

Representative specimens examined. **COLOMBIA. Caquetá:** 10 km below Puerto Rico, 350–400 m, 27 Sep 1975, *Cabrera et al. 3522* (USF); Florencia, Río Orteguaza, 400 m, 21 Mar 1965, *Garcia-Barriga 18198* (US); 10 km S of San José de Fragua, 320 m, 11 Jan 1974, *Gentry et al. 9145* (MO). **Meta:** Puerto Losada, Mina Blanca-Puerto Losada road (16 km), 360–450 m, 23 Feb 1988, *Callejas & Marulanda 5889* (USF); margin of the Río Guayabero, Macarena rapids, 380 m, 23 Jan 1959, *Pinto et al. 304* (P); N side of river near junction of Guejar and Río Zanza, N end of Cordillera Macarena, ca. 500 m, 20 Aug 1950, *Smith & Idrobo 1482* (COL, MO, US). **Putumayo:** E slope of Cordillera Oriental, tributary of the Río Mocoa, near Mocoa, 700 m, 8 Jan 1945, *Ewan 16723* (BM, P); Umbria, 325 m, Oct–Nov 1930, *Klug 1830* (BM, F, K, MO, NY, US). **ECUADOR. Napo:** from Coca to 1 hour in canoe downstream on the Río Napo, (00°26–27'S, 76°41–57'W), 200 m, 18 Mar 1980, *Brandbyge et al. 30232* (AAU, USF); Taisha, Río Guambime, (02°23'S, 77°30'W). 400 m, 19 Jun 1980, *Brandbyge et al. 322601* (AAU, USF); Río Wai si ayá, a northern tributary to Río Aguarico, ca. 6 km upriver from San Pablo, (00°51'S, 76°21'W), 300 m, 10 Aug 1980, *Brandbyge & Asanza 32764* (AAU, USF); Río Wai si ayá, 1 km upstream from the outlet in Río Aguarico, (00°15'S, 76°21'W), 300 m, 6 Aug 1981, *Brandbyge et al. 33260* (AAU, USF); Reserva Biológica Jutan Sacha, Río Napo, 8 km E of Misahuallí, (01°04'S, 77°36'W), 450 m, 24 Apr–5 May 1987, *Cerón 1329* (MO, USF); Reserva Biológica Jutan Sacha, 8 km E of Misahuallí, bank of Río Napo, (01°04'S, 77°36'W), 450 m, 4 Sep 1987, *Cerón et al. 2162* (MO, USF); along road between Puerto Napo and Misahuallí (junction of Río Misahuallí and Río Napo) at Vereda Venesia, 3.8 km W of Misahuallí, (ca. 01°02'S, 77°42'W), 370 m, 2 May 1984, *Croat 58889* (MO, USF); between Cotapino (Concepción) and Río Bueno, ca. 400 m, 21 Feb 1968, *Harling et al. 7154* (GB, USF); Latas, Río Napo, 12 Aug 1968, *Lugo 260* (GB, USF); Apuyam, ca. 6 km from Puerto Napo, 14 Aug 1968, *Lugo 298* (GB, USF); southern side of Río Napo, 3–4 km S of Coca (Puerto Francisco de Orellana), 8 Jan 1973, *Lugo 2546* (GB, USF); Tierra Colorada, ca. 3 km N of Coca (Puerto

Francisco de Orellana), 22 Jan 1973, *Lugo 2916* (GB, USF); San Pablo at Río Napo, 6–7 km SW of Coca (Puerto Francisco de Orellana), 28 Jan 1973, *Lugo 3012* (GB, USF); road between Lago Agrio and El Chaco, 23 Feb 1973, *Lugo 3487* (GB, USF); near Tena, 400 m, 2–11 Apr 1935, *Mexia 7142* (US); Añangu, near outlet of Río Añangu into Río Napo in Parque Nacional Yasuní, ca. 250 m, 30 Jun–9 Jul 1982, *SEF 10261* (AAU). **Marona-Santiago:** Centro Shur Yukutais, Chacras S of Centro, (03°30'S. 78°10'W). 22 Apr 1989, *Bennett & Andrade 3795* (NY, USF); near Mendez, bewteen the Río Paute and Río Upano, 530–760 m, 12 Nov 1944, *Camp E-949* (K, US); Taisha, banks of Río Guaguayme, 460 m, 6 Feb 1962, *Cazalet & Pennington 7681* (K, US); vicinity of Mendez, ca. 620 m, 14 Oct 1989, *Luther et al. 2712A* (SEL, USF). **Pastaza:** Lorocachi, 1–5 km up Río Curaray from military camp, (01°38'S, 75°58'W), 200 m, 30 May 1980, *Branbyge & Asanza 31407* (AAU, USF); Curaray, Valle de la Muerte, (01°25'S, 75°52'W), 240 m, 22 Mar 1980, *Holm-Nielsen et al. 22531* (AAU, USF); Montalvo, along Río Bobonaza 0–1 km N of the military camp, (02°05'S, 76°58'W), 250 m, 16 May 1979, *Løjtnant & Molau 13300* (AAU, USF); Montalvo, within the military camp, (02°05'S, 76°58'W), 250 m, 17–22 May 1979, *Løjtnant & Molau 17470* (AAU); Río Tinguiza, in the vicinity of Canelos, 15 Mar 1971, *Lugo 1689* (GB, USF); Río Bobonaza, near outlet into Río Pastaza, between Destacamento Cabo Pozo and La Boca, (02°30'S, 76°38'W). ca. 275 m, 21 Jul 1980, *Øllgaard et al. 34917* (AAU, USF); Río Pastaza, river banks between the outlets of Río Bobonaza and Río Ishpingo, (ca. 02°34'S, 76°43'W), ca. 275 m, 22 July 1980, *Øllgaard et al. 34983* (AAU, USF). **PERU. Amazonas:** near Kusu, Río Numpatkin, 340–400 m, 10 Mar 1973, *Ancuash 79* (MO); Río Cenepa, vicinity of Huampmi, ca. 3 km from the mouth of the Río Huampami, 200–250 m, 25 Jul 1978, *Ancuash 1115* (MO, USF); Quebrada Chigki Shinuk, Río Cenepa, vicinity of Huampami, ca. 5 km E of Chávez Valdivia, (04°30'S, 78°30'W), 200–250 m, 11 Aug 1978, *Ancuash 1422* (MO, USF); Río Cenepa, vicinity of Huampami, ca. 5 km E of Chávez Valdivia, (04°30'S, 78°30'W), 200–250 m, 14 Aug 1978, *Ancuash 1473* (MO, USF); Río Cenepa, vicinity of Huampami, Quebrada Kachaig, ca. 5 km E of Chávez Valdivia, (04°30'S, 78°30'W), 200–250 m, 15 Aug 1978, *Ancuash 1506* (MO, USF); island 1 km below La Poza, Río Santiago, 180 m, 8 Aug 1979, *Peña 13* (MO, USF). **Huánuco:** just N of Puerto Inca, (09°18'S, 74°58'W), 250–300 m, 15 Sep 1982, *Foster 8811* (MO, USF). **Loreto:** along the Río Pastaza, between Rimachi and Río Witoyacu, (04°15'S, 76°35'W). 31 Jul 1979, *Diaz et al. 1313* (MO, USF); near mouth of the Río Gueppi, ca. 200 m, 18 May 1978, *Gentry et al. 22080* (MO, USF); Florida, Río Putumayo, at mouth of Río Zubineta, 180 m, May–Jul 1931, *Klug 2169* (BM, F, K, MO); Balsapuerto, ca. 220 m, Mar 1933, *Klug 2974* (BM, F, MO); Maucallacta, Río Paranapura, ca. 200 m, Jan 1935, *Klug 3941* (BM, F, K, MO, WIS); near mouth of Río Santiago, 200 m, 25 Nov 1931, *Mexia 6158* (BM, F, G, K, MO, WIS). **San Martín:** E of Tarapoto 8 km, Fundo de San Isidro near Codo Creek, 1,000 m, 15 Aug 1937, *Belshaw 3234* (K); Juan Jui, upper Río Huallaga, ca. 400 m, Oct 1934, *Klug 3851* (BM, F, MO, WIS); Juan Jui, Alto Río Huallaga, 400–800 m, Jan 1936, *Klug 4234* (BM, K, MO); 7–15 km E of Shapojo on road to Chazuta, (06°39'S, 76°30'W, 250 m, 25 May 1986, *Knapp et al 7271* (MO, USF); Quebrada Mamonaquihua to junction with Río Mayo, 9.6 km W of Flores-Mamonaquihua (turnoff is on Km 24 from Tarapoto), (06°36'S, 76°10–11'W), ca. 400 m, 15 May 1986, *Knapp et al. 7406* (MO, USF); Chara del Sr. Manuel Arévalo Silva, along the Río Huallaga, 400 m, 13 Jul 1970, *Schunke Vigo 4106* (F, G); Río de la Plata, 600–700 m, 27 Mar 1975, *Schunke Vigo 8169* (MO, US, USF); mouth of the Río Tocahe, 400 m, 29 Apr 1975, *Schunke Vigo 8329* (MO, USF). **Ucayali:** Quebrada Shesha, tributary of Río Abujao, 1–2 days upriver by "peki-peki", ca. 60–70 km NE of Pucallpa, (08°02'S, 73°55'W), ca. 250 m, 18 Jun 1987, *Gentry & Diaz 58412* (MO, USF); Bosque Von Humboldt, along Quebrada Tahuahillo, ca. 200 m, 20 Jun 1981, *Young 937* (MO, USF). **BRAZIL. Acre:** near mouth of Rio Macauhan (tributary of Rio Yaco), 5 Aug 1933, *Krukoff 5293* (BM, F, G, K, MO). **Amazonas:** Rio Solimões, 2 km below Tabatinga, 24 Jul 1973, *Prance et al. 16771* (K, MO, USF).

ACKNOWLEDGMENTS

I gratefully acknowledge the curators of AAU, BM, CM, COL, F, G, GB, IJ, K, LE, MO, P, SEL, NY, UC, US, VEN, and WIS for making specimens available for study. I thank Bruce Hansen (USF) for his helpful suggestions and Alan Franck (USF) for assistance with graphics. I also acknowledge Rafael Torres Colín (MEXU) and Howard L. Clark (DUKE) for review of the manuscript and helpful suggestions.

REFERENCES

Forero G., E. 1966. La identidad de *Ariaria superba* Cuervo Márquez (Caesalpiniaceae-Bauhinieae). Mutisia 30:[1–7].

Vaz, A.M.S. da F. and A.M.G. de Azevedo Tozzi. 2003. *Aculeatae*, a new series in *Bauhinia* section *Pauletia* (Leguminosae, Caesalpinoideae, Cercideae). Novon 13:141–144.

Wunderlin, R.P. 1983. Three new species of *Bauhinia* (Fabaceae) from Ecuador. Brittonia 35:335–340.

Wunderlin, R.P. 2006. Revision of *Bauhinia* subgenus *Bauhinia* section *Amaria* (Cercideae: Caesalpinioideae: Fabaceae). Sida 22: 97–122.

Wunderlin, R.P., K. Larsen, and S.S. Larsen. 1987. Reorganization of the Cercideae (Fabaceae: Caesalpinioideae). Biol. Skr. 28:1–40.

BOOK REVIEWS

LAWRENCE E. ESTAVILLE AND RICHARD A. EARL. 2008. **Texas Water Atlas.** (ISBN 978-1-60344-020-2, flexbound with flaps). Texas A&M University Press, John H. Lindsey Building, 4354 TAMU, College Station, Texas 77843-4354, U.S.A. (**Orders:** www.tamu.edu/upress, 1-800-826-8911). $24.95, 152 pp., 94 color maps, 17 color photos, 3 tables, 9 graphs, 1 appendix, bibl., index, 8 5/8" × 11 1/4".

Lawrence E. Estaville and Richard A. Earl have compiled and compared geologic, environmental, water and weather data, population and human activity to graphically illustrate Texas' rocky relationship with water in this image-packed reference work, *Texas Water Atlas*. From water demand projections to locations of fish kills and agricultural pollutants to scuba parks and tubing access, no topic is sacred or unexplored. Each chapter is introduced with an easy to understand historic overview based on rigorous scholarship by the authors, both professors of geography. The book, sponsored by the River Systems Institute at Texas State University, is unique. Drawing data from a wide range of authoritative resources, the work provides analysis in context in regard to the numerous variables that impact Texas water supply, usage and quality. *Texas Water Atlas* is a valuable resource for professionals and policy makers in a variety of fields, educators and the lay person.—*Becky Brandenburg, Volunteer, Botanical Research Institute of Texas, Fort Worth, Texas 76102-4025, U.S.A.*

JOHN TYLER BONNER. 2009. **The Social Amoebae: The Biology of Cellular Slime Molds.** (ISBN 978-0-691-13939-5, hbk: alk. paper). Princeton University Press: 41 William Street, Princeton, New Jersey 08540-5237, U.S.A. (**Orders:** http://press.princeton.edu, 1-800-777-4726, 1-800-999-1958 fax, 1-609-258-6305 overseas fax OR orders@cpfsinc.com, California-Princeton Fulfillment Services, 1445 Lower Ferry Road, Ewing, New Jersey 08618, U.S.A.). $19.95, 156 pp., 34 b&w line illustrations, 5 1/2" × 8 1/2".

John Tyler Bonner has spent more than 60 years of study devoted to the biology of the cellular slime molds. His 18 previous books interpret and explain experimental data, beginning in 1959 with his First Edition of *The Cellular Slime Molds,* which was not intended to be taxonomic with descriptive lists of species, but emphasized the unique biology of the life cycle as an experimental model. Bonner states his goal in this current book, "This book is not an encyclopedia, a textbook, or a monograph, it covers only a fraction of all we know about slime molds. Rather, it is an essay on the big lessons we have learned, with a few unconventional and new insights." And in addition, the narrative is "… aimed at the curious layperson …" and in this Bonner excels as a master at explaining complex biological concepts and experimental data now laced with molecular biology and genetics. A more general readership will appreciate and understand the contents of this book because of Bonner's engaging writing style.

Eight topical headings are represented by an Introduction, The Life Cycle, Evolution, Ecology, Behavior of Amoebae and Cell Masses, Morphogenesis, Differentiation, and The Future. These sections are rather short, varying from 5 to 16 pages in length. The Evolution section makes for fascinating reading, especially the recent molecular analysis using SSU rDNA that separates the dictyostelids into four groups as shown on a phylogram. There is not enough space here to describe all of the details in this section, but the phenotypes of chimaeras, heterokaryons, and heterocytons deserve special mention. There is one incredible vignette entitled "Slime Mold Aggression" that describes the discovery of a cellular slime mold in a bat cave that produces a chemical killer compound that destroys and engulfs other amoebae species and eventually fruits and apparently represents a new distinct species. In the Ecology topic there is a section on "Latitudinal Diversity" where species diversity in the warmer tropics is higher and is lower at higher cooler latitudes in the tropics or lower going toward the poles, and this pattern of species diversity follows the same trend in flowering plants. The role of cyclic AMP in the gathering and aggregation of the amoebae is the classic example of chemotactic response and hence the "social amoebae."

This book is not a comprehensive review of dictyostelid biology, but the selected topics are intriguing and simply explained. The Bibliography also is highly selective, and the 10 pages and 125 references are sprinkled with older and newer references. If I had to select a first book on the biology of the cellular slime molds that is readable by the layperson and various age groups from high school to university, this would be the book to pique anyone's interest in this fascinating group of organisms.—*Harold W. Keller, Research Associate, Botanical Research Institute of Texas, Fort Worth, Texas 76102-4025, U.S.A.*

J. Bot. Res. Inst. Texas 3(2): 638. 2009

ERIOGONUM VILLOSISSIMUM (POLYGONACEAE: ERIOGONOIDEAE), A NEW SPECIES ENDEMIC TO ACKER ROCK, OREGON

James L. Reveal

Cornell University
L.H. Bailey Hortorium
Department of Plant Biology
412 Mann Library
Ithaca, New York 14853, U.S.A.
jlr326@cornell.edu

Dana York

California Department of Transportation
1656 Union Street
Eureka, California 95501, U.S.A.
dana_York@dot.ca.gov

Richard Helliwell

Umpqua National Forest
2900 NW Stewart Parkway
Roseburg, Oregon 97471, U.S.A.
rhelliwell@fs.fed.us

ABSTRACT

Eriogonum villosissimum (Polygonaceae), a new species restricted to Acker Rock, a near vertical volcanic rock formation in the Western Cascade Range of Douglas Co., southwestern Oregon, is described and illustrated. The new species is a member of subg. *Oligogonum* and is most closely allied to *E. alpinum*, a narrow endemic confined to north-central California.

RESUMEN

Se describe e ilustra **Eriogonum villosissimum** (Polygonaceae), una nueva especie restringida a Acker Rock, una roca volcánica casi vertical en la Cordillera de las Cascadas occidental del condado de Douglas, en el suroeste de Oregón. La nueva especie es un miembro del subgénero *Oligogonum* y está emparentado con *E. alpinum*, un endemismo confinado al centro-norte de California.

INTRODUCTION

In 2005, while rock climbing in the Western Cascades of southwestern Oregon, York discovered a previously unknown *Eriogonum* Michx. (Polygonaceae Juss.: Eriogonoideae Arn.) growing in crevices and small shelves of a volcanic rock formation known as Acker Rock. The plants form clumps that are scattered over the south-facing vertical faces of the formation. Nearby outcrops were searched in 2006 with no success of finding another population.

TAXONOMY

Eriogonum villosissimum Reveal & D.A. York, sp. nov. (**Figs. 1–2**). Type: UNITED STATES. Oregon. Douglas Co.: Acker Rock, Umpqua National Forest, mainly S of the lookout, 1275 m elev., 528800 E, 4766674 N, Zone 10, 43°03'08"N, 122°38'47"W, T29S, R1E, sec. 13NWNE, 25 Jul 2009, *York et al. 2989* (holotype: NY; isotypes: BH, CAS, HSC, OSC, US).

Ab *Eriogono alpino* differt foliis ovatis (nec ovalibus) et villosis (nec tomentosis), stipitibus brevioribus (0.1–0.3 mm, nec 0.5–0.8 mm), et plantis cum numerosis rosulis (nec rosulis solitariis).

Plants (Fig. 1) low, spreading, compact herbaceous perennials (0.5–)0.8–2.5(–3) dm across, composed of numerous loosely arranged rosettes of tufted leaves at tips of slender, woody caudex branches arising from a stout taproot. **Leaves** in well defined rosettes; petiole 0.5–1.5 cm long, densely white tomentose and appressed to slightly spreading villous, arising from a broadly elongate triangular petiole base 4–8 mm long, 2–3.5 mm wide, tomentose and villous abaxially, sparsely villous to nearly glabrous or glabrous and tannish brown adaxially; blade mostly ovate, 0.5–1.5 cm long, 0.5–1 cm wide, densely white tomentose and appressed to slightly spreading villous abaxially, greenish white and slightly less densely tomentose adaxially, broadly acute to obtuse but tapering abruptly to the petiole, entire, flat or somewhat or slightly enrolled

J. Bot. Res. Inst. Texas 3(2): 639 – 643. 2009

marginally, broadly acute to obtuse or occasionally nearly rounded apically; midvein slightly raised and obscured by tomentum. **Flowering stems** (Fig. 2, left) scapose, spreading or somewhat erect, (5–)7–9(–11) cm long, tomentose and spreading villous, becoming thinly so with age, with a whorl of 3 foliaceous bracts about 1/3 up flowering stem; bracts petiolate (0.5–2 mm long) with ovate blades 5–10 mm long, 4–7 mm wide, densely white tomentose abaxially, less so and more villous adaxially; lower stem portion 1–3 cm long; peduncle 3.5–7 cm long. **Involucres** solitary, campanulate, 4.5–7 mm long, 5–8 mm wide, tomentose and densely villous abaxially, glabrous adaxially; teeth 5–8, erect, broadly acute, 0.5–0.9 mm long. **Pedicels** erect to slightly curved with age, 4–6 mm long, glabrous; bractlets linear, 4–6 mm long, villous. **Flowers** (Fig. 2, right) bright yellow, 2.5–5 mm long on a stipe (0.1–)0.2–0.3 mm long, glabrous; tepals monomorphic, oblong-obovate; stamens slightly exserted with 2.5–5 mm long, slightly pilose basally filaments and oval, yellow anthers 0.2–0.3 mm long; pistil with styles 1.5–2 mm long. **Achenes** light brown, narrowly trigonous, 4–5 mm long, glabrous; embryo straight.

Additional material seen. **U.S.A. Oregon. Douglas Co.:** Umpqua National Forest, on the slopes of Acker Rock, 528938 E, 4766230 N, Zone 10, 43°03'01"N, 122°38'41"W, (NAD 27), 1045 m, 28 Sep 2005, *York & Rusch 2899* (HSC); SE side of Acker Rock, 528988 E, 4766416 N, Zone 10, 43°03'06"N, 122°38'39"W, (NAD 27), 1185 m, 9 Aug 2006, *York & Helliwell 2912* (BH, HSC).

Distribution, habitat, and phenology.—Eriogonum villosissimum (Acker Rock wild buckwheat) is a rare taxon found in Western Cascade Range physiographic province (Fig. 3), near where it interfaces with the Klamath physiographic province. The area is extremely complex geologically. The only known population occurs on the southwest to southeast exposures of the vertical faces of Acker Rock in the South Umpqua River watershed. The site is 30.5 kilometers due west of the northwest corner of Crater Lake National Park. This formation towers over 600 meters above the surrounding landscape. Acker Rock is located in the older Western Cascade Range and is not capped by younger volcanic material like the High Cascade Range (Kays 1970). It is pyroclastic rock formed between the late Eocene to late Miocene according to Kays who mapped Acker Rock as andesite rhyodacite. Orton (2007) refers to Acker Rock as quartz latite, a specific type of andesite rhyodacite.

The plants thrive in full sun where there is little competition from mosses or other vascular plants. Acker Rock wild buckwheat becomes sparse or completely disappears where the vegetation is dense due to shade or gentler slopes. There appear to be several hundred plants growing on Acker Rock ranging from 975 to 1253 m in elevation. Acker Rock is bordered by forest dominated by Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) and madrone (*Arbutus menziesii* Pursh), with shrubby openings consisting of greenleaf manzanita (*Arctostaphylos patula* Greene), and Fremont silk tassel (*Garrya fremontii* Torr.). Other associates include *Brodiaea elegans* Hoover ssp. *elegans*, *Bromus tectorum* L., *Cheilanthes gracillima* D.C. Eaton, *Elymus elymoides* (Raf.) Swezey, *Eriogonum compositum* Douglas ex Benth., *Eriogonum nudum* Douglas ex Benth., *Holodiscus discolor* (Pursh) Maxim., *Koeleria macrantha* (Ledeb.) Schult., *Lomatium hallii* (S. Watson) J.M. Coult. & Rose, *Luina hypoleuca* Benth., *Penstemon rupicola* (Piper) Howell, *Polystichum imbricans* (D.C. Eaton) D.H. Wagner, *Selaginella wallacei* Hieron., and *Vulpia myuros* (L.) C.C. Gmel.

Flowering occurs from June through August. Although no seedlings have been observed, the authors have seen juvenile plants as young as four or five years old.

Relationship.—Eriogonum villosissimum belongs to subg. *Oligogonum* Nutt., a taxon of some 35 species (Reveal 2005) that ranges from Alaska to Mexico and from Virginia and West Virginia to the Pacific coast. While many of the species are widely distributed (e.g., *E. umbellatum* Torr., *E. heracleoides* Nutt., *E. flavum* Nutt.), several have a limited distribution; however, few can match the restricted distributions of *E. villosissimum* and its near relative, *E. alpinum* Engelm. of Scott Mountain, Cory Peak and Mt. Eddy along the Siskiyou and Trinity county line of northern California. The new species may be distinguished by its single involucre with erect teeth atop a stem-like peduncle that is separated from a true aerial stem by a whorl of foliaceous bracts, its glabrous, short-stipitate flowers, villous leaves, stems, peduncles and involucres, and by its branched, matted habit of numerous, loosely arranged rosettes bearing tufts of ovate leaves.

In the subg. *Oligogonum* treatment in *Flora of North America* (Reveal 2005: 331) the new species will key immediately to lead 27:

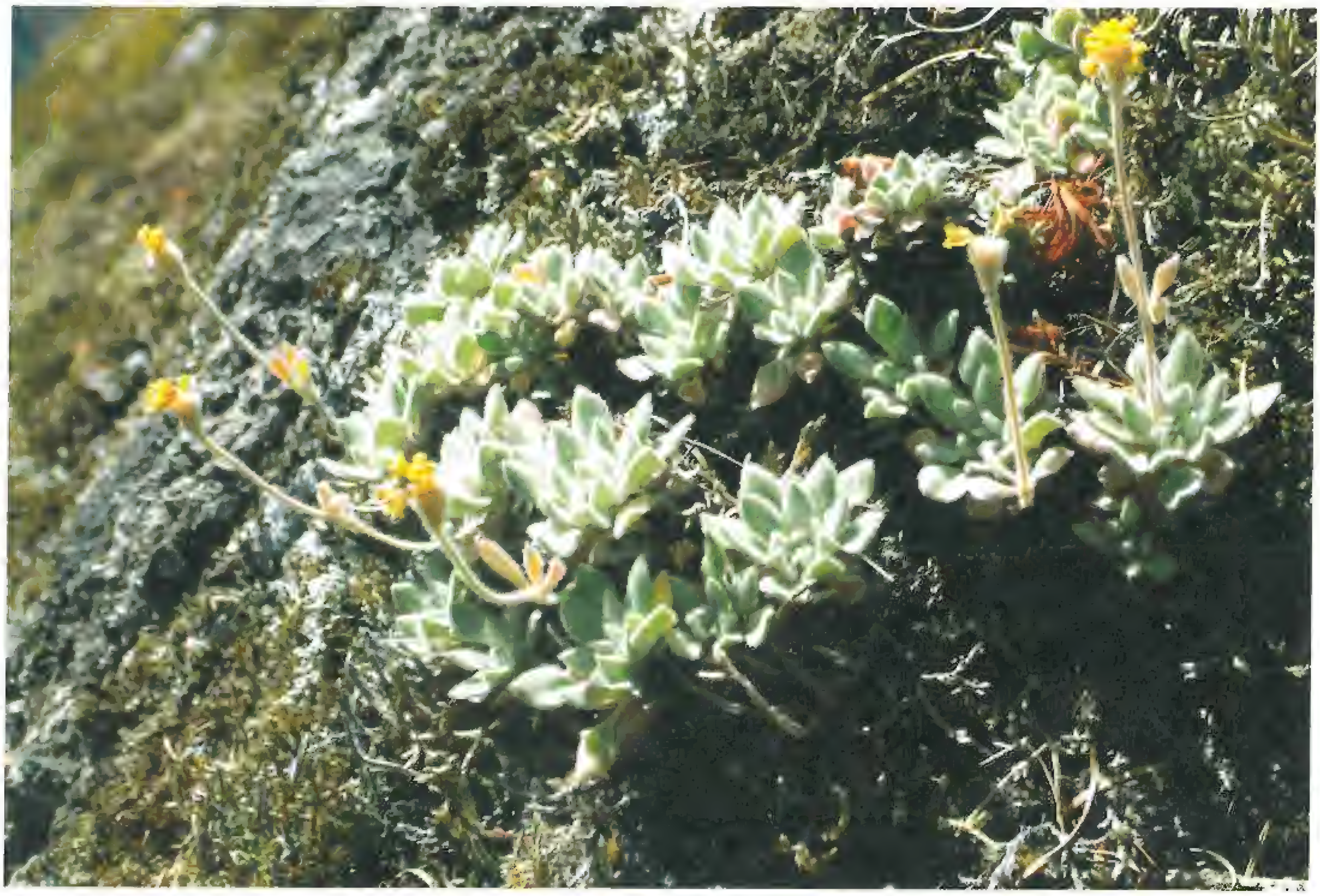


Fig. 1. Habit of *Eriogonum villosissimum*.

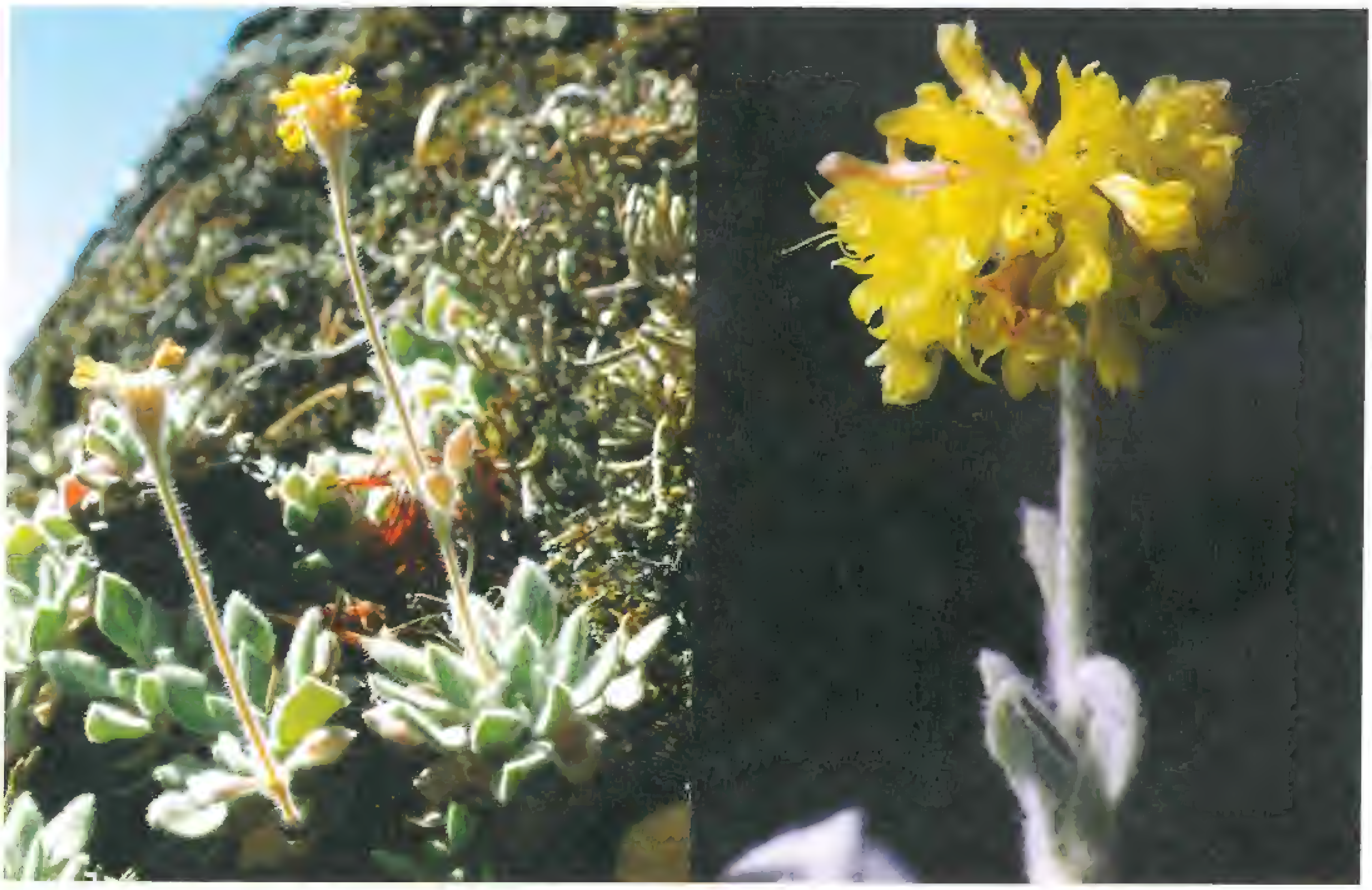


Fig. 2. *Eriogonum villosissimum* – close-up of the habit (left) and detail of flowers (right).

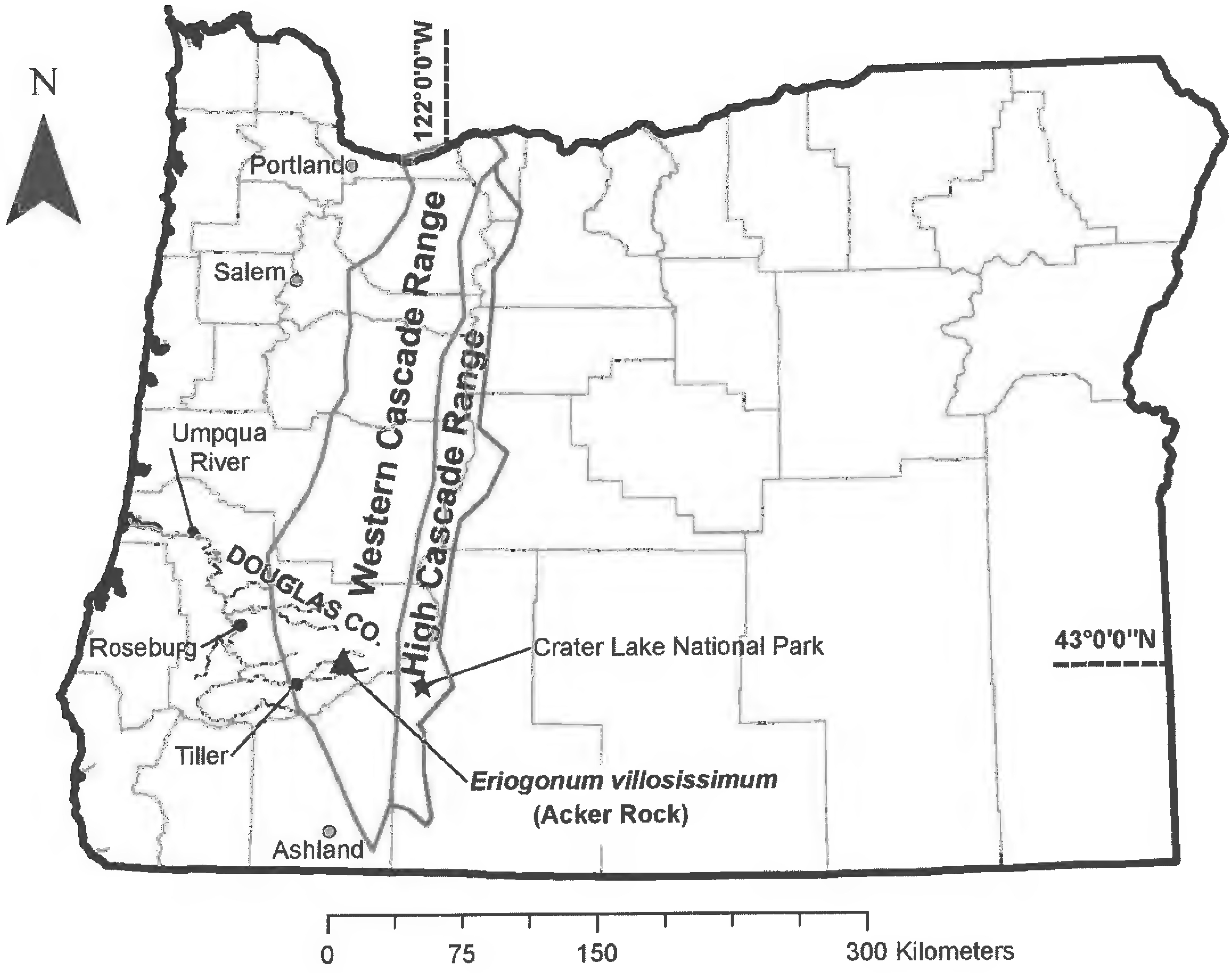

N
122°0'0"W
Portland
Salem
Western Cascade Range
High Cascade Range
Umpqua River
DOUGLAS CO.
Roseburg
Tiller
Crater Lake National Park
43°0'0"N
Eriogonum villosissimum (Acker Rock)
Ashland
0
75
150
300 Kilometers

Fig. 3. Map of Oregon with location.

27. Perianths sparsely pubescent abaxially; North Coast Ranges, Trinity and Tehama counties, California 112. **Eriogonum libertini**
27. Perianths glabrous abaxially; Cascade Range of Douglas County, Oregon, Mt. Eddy and Scott Mountain, Siskiyou and Trinity counties, California, or Sierra Nevada.
    28. Stipe 1–1.5 mm; leaf blades elliptic to ovate; Sierra Nevada 116. **Eriogonum prattenianum**
    28. Stipe (0.1–)0.2–0.8 mm; leaf blades ovate or oval to round-oval; Cascade Range of Douglas County, Oregon, or Mt. Eddy and Scott Mountain, Siskiyou and Trinity counties, California.
        29. Leaf-blades ovate, densely tomentose and villous; stipe (0.1–)0.2–0.3 mm; Douglas County, Oregon, below 2000 m elev. 139a. **Eriogonum villosissimum**
        29. Leaf-blades oval to round-oval, densely tomentose but not villous; stipe 0.5–0.8 mm; Mt. Eddy and Scott Mountain, Siskiyou and Trinity counties, California, above 2000 m elevation 140. **Eriogonum alpinum**

Conservation.—Acker Rock wild buckwheat, previously unknown and uncollected, is rare due to its lithophytic nature on old volcanic rock. The area is managed by the United States Forest Service as a timber emphasis area. There is an unmanned lookout on Acker Rock available for seasonal use by the public as a rental; it is accessible by way of a short hiking trail through the forest on the northeast side of Acker Rock. Because the *Eriogonum* is confined mainly to nearly vertical rock faces, technical rock climbing is the only way of reaching most of the population. As a preface to his description of the 20 established climbs on Acker Rock, Orton (2007) points out to climbers that the rare buckwheat is "easily avoided while climbing." Anthropogenic impacts are more likely from climbers establishing new routes, a factor that will be critical in future management decisions. Although seedlings are the most vulnerable to impacts, the seasonal closure (1 January to approximately 15 July) for nesting peregrine falcons on Acker Rock affords some protection during the early growing season.

ACKNOWLEDGMENTS

We wish to acknowledge, with thanks especially by the senior author, the assistance given to us by Gregg Orton, Bobbi Orton and Harold Hall, all adventurous climbers, who aided us in obtaining a small collection of this rare species. Without their efforts far fewer observations would have been made. For views of Acker Rock, see http://www.summitpost.org/mountain/rock/153184/acker-rock.html and in particular http://www.summitpost.org/image/441640/153184/acker-rock.html, a most interesting place to collect a plant. We are grateful to Kenton L. Chambers for his prompt and useful review and, as always, Barney Lipscomb for his comments and help.

REFERENCES

Kays, M.A. 1970. Western Cascades volcanic series, South Umpqua Fall region, Oregon. The Ore Bin 32:1–94.

Orton, G. 2007. Rock climbing western Oregon. Volume 2. The Umpqua. Mountain N' Air Books, La Crescenta, CA.

Reveal, J.L. 2005. 44a. *Polygonaceae* Jussieu subfam. *Eriogonoideae* Arnott, Encycl. Brittannica (ed. 7), 5:126. 1832 • Wild buckwheat subfamily. Fl. N. Amer. 5:218-478.

BOOK REVIEW

Kevin Williams. 2007. **Seed to Elegance: Kentia Palms of Norfolk Island, South Pacific.** (ISBN 978-0-9775121-1-9, pbk.). First published by Studio Monarch, Norfolk Island, 2899, South Pacific. (**Orders:** seedtoelegance@gmail.com, 1-248-885-9255). $18.95, 72 pp., numerous color and b&w images, 7" × 9".

Seed to Elegance: Kentia Palms of Norfolk Island, South Pacific is divided into three sections that provide details on the origins, industry, and design of the kentia palm. The first section provides the reader with details on the history of the kentia palm from its discovery on Lord Howe Island to its arrival at various locations around the world. This species was initially thought to be a sign of wealth and was a much sought after plant that was used in decorating palaces and landscaping. The author then takes a closer look at the specific steps that are involved in the industry of harvesting, seed planting, exporting, and distribution. He provides the reader with a history of how the industry grew and has expanded today. The final section provides instructions on the proper care required by kentia palms.

The author used very easy to understand terms and used images from several centuries to specifically show the reader the visual history of this particular plant. This book was a very quick read that provides information concerning the history and dispersal of the kentia palm. It would be a good read for any naturalist or person that is eager to learn more about this particular species of palm.—*Keri McNew, MS Biology, Programs Manager, Botanical Research Institute of Texas, Fort Worth, Texas 76102-4025, U.S.A.*

NOMENCLATURAL INNOVATIONS IN *PHLOX* (POLEMONIACEAE), WITH UPDATED CIRCUMSCRIPTION OF *P. CAESPITOSA*, *P. DOUGLASII*, *P. MISSOULENSIS*, AND *P. RICHARDSONII*

James H. Locklear

7431 Briarhurst Circle
Lincoln, Nebraska 68506, U.S.A.
jimlocklear@gmail.com

ABSTRACT

In preparation for a forthcoming manuscript on *Phlox*, seven nomenclatural innovations are made: **Phlox austromontana** Coville subsp. **jonesii** (Wherry) Locklear, comb. et stat. nov.; **Phlox austromontana** subsp. **lutescens** (S.L. Welsh) Locklear, comb. et stat. nov.; **Phlox condensata** subsp. **covillei** (E.E. Nelson) Locklear, comb. et stat. nov.; **Phlox pilosa** L. subsp. **longipilosa** (Waterf.) Locklear, comb. et stat. nov.; **Phlox richardsonii** Hook. subsp. **borealis** (Wherry) Locklear, comb. nov.; **Phlox subulata** L. subsp. **setacea** (L.) Locklear, comb. et stat. nov.; **Phlox villosissima** subsp. **latisepala** (Wherry) Locklear, comb. nov. Taxonomic circumscriptions of *P. caespitosa*, *P. douglasii*, and *P. richardsonii* are provided in support of these nomenclatural changes, along with an updated circumscription of *P. missoulensis*.

RESUMEN

Se hacen siete novedades nomenclaturales en la preparación de un futuro tratamiento de *Phlox*: **Phlox austromontana** Coville subsp. **jonesii** (Wherry) Locklear, comb. et stat. nov.; **Phlox austromontana** subsp. **lutescens** (S.L. Welsh) Locklear, comb. et stat. nov.; **Phlox condensata** subsp. **covillei** (E.E. Nelson) Locklear, comb. et stat. nov.; **Phlox pilosa** L. subsp. **longipilosa** (Waterf.) Locklear, comb. et stat. nov.; **Phlox richardsonii** Hook. subsp. **borealis** (Wherry) Locklear, comb. nov.; **Phlox subulata** L. subsp. **setacea** (L.) Locklear, comb. et stat. nov.; **Phlox villosissima** subsp. **latisepala** (Wherry) Locklear, comb. nov. Se aportan las circunscripciones taxonómicas de *P. caespitosa*, *P. douglasii*, y *P. richardsonii* en apoyo de estos cambios nomenclaturales, junto con una circunscripción puesta al día de *P. missoulensis*.

Phloxes are components of a remarkably diverse array of plant communities and ecological systems across North America, and are often among the most common herbaceous species in the associations in which they occur. Examples include *Phlox diffusa* in subalpine grasslands of the Olympic Mountains, *P. muscoides* in Wyoming Basin rock outcrop communities, *P. pulvinata* in Rocky Mountain alpine fell-fields, and *P. subulata* in barrens and glades in the eastern United States.

The most recent monograph on the genus *Phlox* (Polemoniaceae) is that of Wherry (1955). A forthcoming manuscript on *Phlox* (Locklear, in prep.) requires nomenclatural changes for a number of taxa, proposed here to make these names available for the work. Four of these are changes in rank from variety to subspecies for consistency with concepts of rank in the forthcoming work and those of Wherry, who used "subspecies" in preference to "variety." The concept of subspecies is used here to delimit population systems that exhibit geographic variation and distinctive ecological associations.

Justification for the proposed new combination of *P. condensata* subsp. *covillei* requires updated circumscriptions of *P. caespitosa* and *P. douglasii*, which are provided here. Justification for the proposed new combination of *P. richardsonii* subsp. *borealis* requires updated circumscription of *P. richardsonii*, also provided. Additionally, an updated circumscription of *P. missoulensis* is provided.

NOMENCLATURAL INNOVATIONS IN *PHLOX*

Phlox austromontana Coville subsp. **jonesii** (Wherry) Locklear, comb. et stat. nov. Basionym: *Phlox jonesii* Wherry, Notul. Nat. Acad. Nat. Sci. Philadelphia 146:8, fig. 5. 1944; *Phlox austromontana* Coville var. *jonesii* (Wherry) S.L. Welsh, Great Basin Naturalist 45:792. 1985. Type: UNITED STATES. Utah. Washington Co.: Zion Canon, 07 May 1923, *M.E. Jones s.n.* (holotype: US!; isotypes: CAS, PH, digital image! RSA-POM, digital image!).

J. Bot. Res. Inst. Texas 3(2): 645 – 658. 2009

Phlox austromontana Coville subsp. **lutescens** (S.L. Welsh) Locklear, comb. et stat. nov. Basionym: *Phlox austromontana* Coville var. *lutescens* S.L. Welsh, Great Basin Naturalist 45:792. 1985; *Phlox lutescens* (S.L. Welsh) S.L. Welsh, Utah Fl. ed. 3. 494. 2003. Type: UNITED STATES. Utah. Garfield Co.: T33S, R14E, SW1/4 Sec. 1, along Orange Cliffs Rd, E of hwy 95, 4500 ft elev., Rimrock – blackbrush, ash, squawbush, comm., 11 May 1983, *S.L. Welsh, B. Welsh & M. Chatterley 21972* (holotype: BRY; isotypes: NY, internet image!).

In his paper on the *P. austromontana* complex, Welsh (1985) recognized four varieties—the first-described and most widespread form (var. *austromontana*) plus three intergrading expressions (vars. *jonesii*, *lutescens*, and *prostrata*) of much more limited distribution occurring in the canyon country of southern Utah and adjacent Arizona. These taxa are distinguished at the rank of subspecies because of their discrete distributions and unique ecological associations. The combination *P. austromontana* subsp. *prostrata* has been published previously (Wherry 1939).

Phlox condensata (A. Gray) E.E. Nelson subsp. **covillei** (E.E. Nelson) Locklear, comb. et stat. nov. Basionym: *Phlox covillei* E.E. Nelson, Revis. W.N. Amer. Phlox 15. 1899. Type: UNITED STATES. California: Inyo Co.: Black Canon, White Mountains, 08 Jul 1891. *F.V. Coville with F. Funston 1801* (holotype: destroyed by fire: CAS; neotype, designated by Wherry 1942: US!; isotypes: B, GH! K, NY, internet image! PH, digital image!).

The taxonomic history of *P. condensata* is complex. Gray (1870) described *P. caespitosa* var. *condensata* from type material collected by Charles Christopher Parry in alpine habitat in the Southern Rocky Mountains of Colorado (Hololtype: GH!; Isotypes: ISC NY, internet image! PH, digital image!). Elias Nelson (1899a) elevated it to species rank as *P. condensata*. Wherry (1941, 1955) reduced it to *P. caespitosa* subsp. *condensata*, but Cronquist (1959) elevated it back to species rank. As detailed in the circumscription of *P. caespitosa* that follows, *P. condensata* is treated here at the rank of species.

Elias Nelson (1899) described *P. covillei* from type material collected in the White Mountains of eastern California, and subsequent exploration of the Intermountain West revealed this entity to occur in alpine/subalpine situations in a number of other high elevation mountain ranges of the Great Basin as well as in the Sierra Nevada. Wherry (1942, 1955) affirmed recognition of this taxon at the species level, but Cronquist (1959) reduced it to synonymy under *P. condensata*. Wherry (1969) disagreed, defending recognition of *P. covillei* on the basis of morphological differences and complete geographic separation from *P. condensata* of the Rocky Mountains, but Cronquist (1984) was not convinced, noting, "I am unable to distinguish the Colorado plants from more western materials." While morphological differences cited by Wherry are not profound (see key below), the taxon *covillei* warrants recognition as a subspecies because of its entirely separate range, a relationship paralleled in the similar bi-centric distribution pattern of the bristlecone pine complex, with the Southern Rocky Mountain expression recognized as *Pinus aristata* and the Intermountain expression as *Pinus longaeva* (Bailey 1970). *Phlox condensata* is strongly associated with bristlecone pine subalpine woodland, subsp. *condensata* with *Pinus aristata* in the Rockies of Colorado and New Mexico and subsp. *covillei* with *Pinus longaeva* in Great Basin mountain ranges in California and Nevada.

KEY TO THE SUBSPECIES OF *PHLOX CONDENSATA* (A. GRAY) E.E. NELSON

Plant composed of discrete divergent shoots; pubescence rather sparse, leaves linear-subulate, ciliate; inflorescence herbage glandular-pubescent; Southern Rocky Mountains in Colorado and New Mexico ____ subsp. **condensata**

Plant composed of interlacing shoots; pubescence rather copious; leaves narrow-elliptic, copiously coarse-ciliate, the margin markedly thickened; inflorescence herbage densely pubescent with coarse hairs, only some gland-tipped; Sierra Nevada of California and mountains of the Great Basin in California and Nevada ____ subsp. **covillei** (E.E. Nelson) Locklear

Interpreting floristic and ecological literature in relation to *P. condensata* is made difficult by the confused nomenclature surrounding this species and its subspecies. Literature pertaining to subsp. *condensata* (generally as *P. condensata*) includes these: Baker 1983; Boyce et al. 2005; Cockerell 1903; Cox 1933 (as *P. caespitosa*); Hartman & Mitchell 1979; Hartman & Rottman 1985, 1988 (as *P. pulvinata*); Kiener 1967; Langenheim 1962 (as *P. caespitosa*); Shepherd 1975 (as *P. caespitosa*); Weber & Wittmann 2001a, 2001b; Wooton & Standley 1915 (as *P. caespitosa*). Literature pertaining to subsp. *covillei* (generally as *P. covillei*) includes these: Billings & Thompson 1957; Botti & Sydoriak 2001 (as *P. condensata*); Chabot & Billings 1972; Clokey 1951; Goodrich 1981 (as *P. condensata*); Kartesz 1988; Kimball et al. 2004 (as *P. condensata*); Krantz 1994 (as *P. condensata*); Linsdale et al. 1952; Lloyd & Mitchell 1973; Major & Taylor 1977; Marchand 1973; Mooney et al. 1962; Munz 1974; Munz & Keck 1959; Nelson & Kennedy 1906 (as *P. dejecta*); Patterson & Wilken 1993 (as *P. condensata*); Peinado et al. 2005; Pemble 1970; Sharsmith 1940 (as *P. caespitosa* var. *condensata*); Spira 1991 (as *P. condensata*); Wenk & Dawson 2007 (as *P. condensata*); Wherry 1942; Wright & Mooney 1965.

Phlox pilosa L. subsp. **longipilosa** (Waterf.) Locklear, comb. et stat. nov. Basionym: *Phlox longipilosa* Waterf., Rhodora 73:577. 1971; *Phlox pilosa* L. var. *longipilosa* (Waterf.) J. & C. Taylor, Sida 9:183. 1981. Type: UNITED STATES. Oklahoma. Kiowa Co.: N slopes of granite mountains S of Lake Altus, 29 May 1957, *U.T. Waterfall 13134* (holotype: OKLA!; isotypes: GH! KANU, OKL, PH, digital image!).

Waterfall (1971) recognized this entity as related to but distinct from *P. pilosa*. Taylor and Taylor (1981) reduced it to a variety of *P. pilosa*. *Phlox pilosa* subsp. *longipilosa* is endemic to granitic soils in the Wichita Mountains region of southwestern Oklahoma, remote from the main distribution of *P. pilosa* to the east. It is distinguished from the broader *P. pilosa* complex as shown in the following key.

Stems per plant numerous, with 10–18 leaf-nodes; uppermost leaves and bracts alternate, sometimes as many as 7 to 8 being so; inflorescence stems and calyx densely pilose with long jointed hairs mostly 2–4 mm long; calyx-lobes apically bearing relatively long, somewhat twisted awn ________ **Phlox pilosa** subsp. **longipilosa** (Waterf.) Locklear

Stems per plant few, ca. 6–14 leaf-nodes; uppermost leaves and bracts mostly opposite; hairs of upper stems and calyx less than 1 mm long; calyx-lobes aristate ________ **Phlox pilosa** sensu lato

Phlox richardsonii subsp. **borealis** (Wherry) Locklear, comb. nov. Basionym: *Phlox borealis* Wherry, Gen. Phlox: 126. 1955; *Phlox sibirica* L. subsp. *borealis* (Wherry) Shetler, Rhodora 65:220. 1963; *Phlox sibirica* L. var. *borealis* (Wherry) B. Boivin, Naturaliste Canad. 93:1062. 1967. Type: UNITED STATES. Alaska: Nome, Alaska on Anvil ridge, altitude 500 ft, slope 20%, moisture fair, rocky loam, associated plants *Epilobium, Salix reticulata, Cassiope tetragona, Anemone multiceps*, 23 Jun 1929, *W.B. Miller 121 – c* (holotype: US!).

Hooker (1838) described *P. richardsonii* from type material collected by John Richardson while serving on Captain John Franklin's Second (1825–1827) Overland Expedition to the Arctic (holotype: K; isotypes: BM, digital image! GH! NY, internet image!). Richardson collected the type in 1826 near Cape Bathurst on the Arctic seacoast of northwest Canada.

The identity of *P. richardsonii* has long been tied up with that of *P. sibirica*, described by Linnaeus (1753) from original material collected in "Asia boreali," most likely in southern Siberia. Although Hooker (1838) considered the two species distinct, he identified specimens of *P. richardsonii* collected in 1826 by Lay and Collie at Kotzebue Sound on the Alaskan coast as *P. sibirica*, noting the plants differed "in no respect" from material collected in Asia. The treatment of phloxes from the North American Arctic as *P. sibirica* continued well into the twentieth century, as exemplified by the works of such notable students of the Arctic flora as Porsild (1939a, 1939b) and Hultén (1948, 1968).

Wherry (1955) separated the phloxes of the North American Arctic from *P. sibirica*, recognizing *P. borealis*, *P. richardsonii* subsp. *alaskensis*, and *P. richardsonii* subsp. *richardsonii*. Major morphological differences cited by Wherry are reflected in the key below. Not noted by Wherry are significant ecological differences, *P. sibirica* being associated with mid-elevation, graminoid-dominated steppe communities, primarily in the cold, dry interior plateaus of Middle Asia (Ermakov et al. 2002, 2006; Grubov 2001; Knyaszev et al. 2007; Krasheninnikov 1937; Mirkin et al. 1985; Peshkova 1972, 2001; Sochava 1945; Yurtsev 1963, 1967, 1972), and *P. richardsonii* occurring almost entirely above the Arctic Circle in association with alpine dwarf-shrubland and alpine herb communities.

Plant an upstanding suffrutescent perennial, sparingly and diffusely branched, forming tufts 8–15 cm tall from a taproot, the erect-ascending flowering shoots 5–10 cm long with ca. 5 leaf-nodes below the inflorescence;

leaves linear, long-acuminate, sometimes falcate, thinnish, maximum length 30–60 cm; inflorescence (one-) three- to six-flowered, maximum pedicel length 20–40 mm; ovary/capsule typically with 2 ovules/seeds per locule ________ **Phlox sibirica**

Plant a caespitose perennial herb forming loose to dense mats 3–12 cm tall from a short-branched caudex, the flowering shoots 2–6 cm long; leaves linear to subulate, maximum length 5–15 mm; inflorescence one- to three-flowered, pedicel length 1–8 (up to 25) mm; ovary/capsule typically 1 ovule/seed per locule ________ **Phlox richardsonii** complex

Phlox richardsonii is recognized here as a complex of intergrading forms largely limited to the western North American Arctic, differing morphologically in stature and size of floral parts and occupying distinct floristic regions of the Arctic. As shown in the key below, three subspecies are recognized here under the first-published name of *P. richardsonii*, necessitating the new combination of *P. richardsonii* subsp. *borealis*.

KEY TO THE SUBSPECIES OF *PHLOX RICHARDSONII* HOOK.

1. Longest pedicels (4–)8–25 mm long; corolla-lobe 8–14 mm long; styles 7–12 mm long; associated with coastal areas of the Bering Strait ________ subsp. **borealis** (Wherry) Locklear
1. Longest pedicels 1–6 mm long; corolla-lobe 6–9 mm long; styles 4–8 mm long.
   2. Leaves flattened, thinnish, 8–15 mm long; pubescent with rather coarse hairs; calyx 7–10 mm long; corolla-limb diameter up to 2.2 cm; associated with higher interior foothills and mountains of Alaska, Yukon, and the Northwest Territories ________ subsp. **alaskensis** (Jordal) Wherry
   2. Leaves awl-shaped, thickish, 5–10 mm long; pubescent with fine, arachnoid hairs; calyx 5–7 mm long; corolla-limb diameter ca. 1 cm; associated with the Arctic seacoast ________ subsp. **richardsonii**

The distribution of the *P. richardsonii* complex ranges from the Bering Sea region of Alaska east to northwest Canada, mostly north of the Arctic Circle, with a few highly limited occurrences reported from Asia. The first-described expression (subsp. *richardsonii*) is known from relatively few stations in northwest Canada and northern Alaska. The core of its range is along the Arctic seacoast of Canada, from Cape Bathurst in the District of Mackenzie of the Northwest Territories, east to Clifton Point, a mainland promontory on the coast of Nunavut Territory. It also occurs on Banks Island of the Canadian Arctic Archipelago. Floristic and ecological literature pertaining to subsp. *richardsonii* (generally as *P. richardsonii*) includes these: Aiken et al. 1999; Freedman et al. 1990 (as *P. sibirica*); Holm 1922; Johansen 1924; Kuc 1974, 1996; MaCoun & Holm 1921.

Phlox richardsonii subsp. *alaskensis* occurs in the higher interior foothills and mountains of Alaska, Yukon, and the Northwest Territories. It occurs most abundantly in the Brooks Range of northern Alaska, but also in the Alaska Range of central Alaska and in the Mentasta, Nutzotin, and Wrangell mountains in south-central Alaska. It also occurs in the Ogilvie Mountains and Richardson Mountains of the Yukon Territory. Floristic and ecological literature pertaining to subsp. *alaskensis* includes these: Carlson et al. 2006a (as *P. alaskensis*); Cody et al. 2002 (as *P. alaskensis*); Cook & Roland 2002 (as *P. richardsonii*); Cooper 1989 (as *P. sibirica*); Drew & Shanks 1965 (as *P. sibirica*); Jordal 1952 (as *P. alaskensis*); Juday 1989 (as *P. sibirica*); Porsild 1972 (as *P. alaskensis*); Spetzman 1959 (as *P. sibirica*); Walker et al. 1989, 1991, 1994 (as *P. sibirica*).

Phlox richardsonii subsp. *borealis* is distributed along the coast of the Seward Peninsula of northwest Alaska, in the vicinity of the Bering Strait. It also has been reported (as *P. alaskensis*) on the Asiatic side of the Bering Strait in the far southeastern portion of the Chukotka Peninsula of the Russian Far East (Balandin & Razzhivin 1980; Razzhivi 1986, 1994). On American side of the Strait, occurrences of *P. richardsonii* subsp. *borealis* are known from coastal areas of Norton Sound and Kotzebue Sound, and from Cape Krusenstern, Cape Lisburne, Cape Prince of Wales, Cape Sabine, and Cape Thompson. Floristic and ecological literature pertaining to subsp. *borealis* includes these: Carlson et al. 2006b (as *P. alaskana*); Hansen 1951 (as *P. sibirica*); Hutchison 1934 (as *P. sibirica*); Johnson et al. 1966 (*P. sibirica*); Kelso 1989 (as *P. sibirica*); Muir 1917 (as *P. sibirica*); Porsild 1939a, 1939b (as *P. sibirica*); Razzhivin 1986, 1994 (as *P. alaskensis*); Shetler 1963 (as *P. sibirica* subsp. *borealis*).

The geographic distribution of these subspecies show parallels with patterns of speciation in the genus *Douglasia* (Primulaceae) (Kelso 1992; Kelso et al. 1994). It also roughly corresponds to the extent of three floristic subdivisions of the Arctic described by Yurtsev (1994), each reflecting regional differences in environment and climate. Subspecies *richardsonii* is associated with the *Central Canada* subprovince, which is markedly continental. Subspecies *alaskensis* is associated with the *North Alaska* subprovince, which encompasses the more continental parts of the Brooks Range and its northern foothills, the Richardson Mountains, and the Arctic slope of Alaska with its cold, true Arctic climate, a region which experiences colder winter temperatures than coastal areas but also experiences more summer heat and dryness. Subspecies *borealis* is associated with the *Beringian Alaska* subprovince, which encompasses the Alaskan coast of the Bering Strait, notably the Seward Peninsula and coastal areas of Kotzebue Sound, Norton Sound, and the Chukchi Sea. This subprovince has an oceanic climate due to the influence of a warm sea current. While the summer climate along the Bering Strait is generally colder, windier, and more overcast than continental areas of Alaska, the overall climate is less harsh than in the interior mountains due to the proximity of the sea. Species *borealis* also occurs on the Asiatic side of the Bering Strait on the coast of the Chukotka Peninsula in the parallel *Beringian Chukotka* subprovince. A number of vascular plants are considered "Beringian"—characteristic of or endemic to the Bering Sea region on both the American and Asiatic sides of the Strait (Kelso 1987, Yurtsev 1994), with the floras of these coastal areas being more diverse than that toward the interior (Kelso 1989).

Phlox subulata L. subsp. **setacea** (L.) Locklear, comb. et stat. nov. Basionym: *Phlox setacea* L., Sp. Pl. 1:153. 1753; *Phlox subulata* L. subsp. *eu-subulata* Brand var. *setacea* (L.) Brand, Pflanzenr. (Engler) 4(250):78. 1907. Lectotype, designated by Reveal et al. 1982: "*Lychnidea Blattariae accedens Virginiana Camphoratae...*" in Plukenet, Phytographia: table 98, fig. 3, 1691; Almagestum botanicum 233. 1696; Typotype, designated by Reveal et al 1982: Herbarium Sloane 90: 59 (BM-SL).

Linnaeus established the name *P. setacea* in *Species Plantarum* (1753) based on a figure (table 98, figure 3) published in Plukenet's *Phytographia* (1691). The epithet *setacea* was subsequently misapplied by Curtis (1798) in the *Botanical Magazine* for what was an illustration and description of *P. nivalis* (Loddiges 1823; Sweet 1827) and the two names became entangled until Wherry (1929, 1937) sorted out the confusion and reinstated *P. nivalis*. Wherry (1929) interpreted *P. setacea* as a glabrate expression of *P. subulata* and later (1955) placed the Linnaean name in synonymy under *P. subulata* subsp. *subulata*. Reveal et al. (1982) located a pertinent specimen in the Sloane Herbarium of the Natural History Museum, London (BM-SL), which they recognized as the typotype of the Plukenet figure. Noting that the specimen clearly matched the attributes of what Wherry (1929) treated as *P. subulata* var. *australis*, Reveal et al. (1982) demonstrated that the Linnaean epithet *setacea* has priority over *australis*, and resurrected *P. subulata* var. *setacea*, a name proposed by Brand (1907). This taxon is recognized here at the rank of subspecies.

Phlox villosissima (A. Gray) Small subsp. **latisepala** (Wherry) Locklear, comb. nov. Basionym: *Phlox pilosa* L. subsp. *latisepala* Wherry, Gen. Phlox 47. 1955. Type: UNITED STATES. Texas. Kerr Co.: 1600–2000 ft, 19–25 Apr 1894 *A.A. Heller 1641* (holotype: MO; isotypes: G, GH! NY, internet image! PH, digital image! US!).

Gray (1870) described *P. drummondii* var. *villosissima* from type material collected by Charles Wright in 1851 on the "Pebbly bars of the Nueces [River]" in southern Texas (holotype: GH!). Small (1903) elevated it to species rank, but still considered *P. villosissima* an annual like *P. drummondii*. Whitehouse (1935) relocated the likely site of Wright's collection by searching crossings of the Nueces River near Uvalde, Texas where she found "numerous plants that closely matched the type" growing in the chalky gravel beds of the river and determined that the entity is a perennial rather than an annual, providing further merit for recognition as a species. Wherry (1955) recognized the distinctiveness of this taxon, but treated it as *P. pilosa* subsp. *riparia*.

Levin (1968) reinstated *P. villosissima* as a species distinct from *P. pilosa*, reproductively isolated by ecology, flowering season, and incompatibility barriers. Levin initially supported his view with evidence from karyology (Levin 1966; Smith & Levin 1967) and experimental crosses (Levin 1966). *Phlox villosissima* is a tetraploid ($2n = 28$) and appears to be an allotetraploid. These data, coupled with those from studies of seed protein chemistry (Levin & Schaal 1970) and plant pigment (flavonoid) chemistry (Levy & Levin 1971, 1974) indicate *P. villosissima* could be the stabilized derivative of past hybridization between *P. pilosa* subsp.

pilosa and *P. drummondii* subsp. *mcallisteri*. Evidence from more recent molecular studies generally support this hypothesis but also indicate more complicated relationships (Ferguson et al. 1999; Ferguson & Jansen 2002).

Elias Nelson (1899) described *P. aspera* from type material collected by Amos Arthur Heller in central Texas. Brand (1907) discerned a relationship with *P. villosissima*, treating the taxon as *P. drummondii* subsp. *drummondii* var. *villosissima* subvar. *aspera*. Wherry (1955, 1966) also recognized a close relationship between the two, but, as with *P. villosissima*, treated *P. aspera* as a variant of *P. pilosa*, proposing *P. pilosa* subsp. *latisepala* (Wherry noted Nelson's *aspera* was a homonym and unavailable as a subspecific epithet). Levin (1968) reinstated *P. aspera*, citing the same justifications as for *P. villosissima* and noting the entity occupied an intermediate position between *P. villosissima* and *P. pilosa* in terms of morphology and ecology. Both Levin and Wherry considered the combined range of this pair of taxa to be centered on the Edwards Plateau of Texas, with *P. villosissima*/*P. pilosa* subsp. *riparia* most common in the western portion of the plateau and *P. aspera*/*P. pilosa* subsp. *latisepala* occurring more to the east and north.

Ferguson (1998) cited possible local integration of these two entities with each other and with *P. pilosa* (also noted by Wherry [1966]) as reason for maintaining them at the subspecies level pending further study. In the most recent treatment of *Phlox* in Texas, Turner (1998) combined both under *P. villosissima*. While these taxa may intergrade where their ranges overlap, they show distinctive morphological differences and ecological associations toward the outer portions of the overall range of the complex (see key below). The taxon formerly treated as *P. aspera* and *P. pilosa* subsp. *latisepala* is recognized here as a subspecies of *P. villosissima*, necessitating the new combination.

KEY TO THE SUBSPECIES OF *PHLOX VILLOSISSIMA* (A. GRAY) SMALL

Plant with well-developed slender woody rhizomes producing multiple erect-ascending stems; stems tending to be branched with nodes rather crowded, 12–25 cm tall; inflorescence herbage densely glandular-pubescent; xeric habitat in western portion of species range, notably riverwash habitat and talus slopes ____ subsp. **villosissima**

Plant not rhizomatous; stems tending to be simple, moderately stout, 22–45 cm tall; pubescent throughout with pointed hairs, with inflorescence herbage moderately glandular; occurs in more mesic habitat in eastern portion of species range ____ subsp. **latisepala** (Wherry) Locklear

CIRCUMSCRIPTION OF *PHLOX CAESPITOSA* NUTT.

Nuttall (1834) described *P. caespitosa* from type material collected by Nathaniel Jarvis Wyeth in 1833 on the return (eastbound) leg of his first Oregon Expedition (1832–1833). Nuttall described the type locality as "Flat-Head river, on the sides of dry hills," adding, "Flowering about the 20th of April." The date "April 22nd" is written on the holotype specimen label (BM) and on isotypes (GH, PH) of *P. caespitosa*. According to Wyeth's journal, 22 April 1833 was the day he departed "Flathead Post," also called "Flathead House," a trading post historians place not on the Flathead River but on the Clark Fork River near the present-day town of Thompson Falls in northwestern Montana (Sanders County) (McKelvey 1955). A number of more recent collections of *P. caespitosa* have been made in the vicinity of Thompson Falls.

Wherry (1941, 1955) interpreted *P. caespitosa* as a complex consisting of a taller, open-growing form (subsp. *caespitosa*) occurring at middle elevations in the Rocky Mountains, plus three shorter, more compact expressions (subspp. *condensata*, *platyphylla*, and *pulvinata*) occurring at higher elevations under alpine/subalpine conditions. Cronquist (1959) revised this complex, raising the high elevation forms to the rank of species as *P. condensata* and *P. pulvinata* (incorporating subsp. *platyphylla*) and interpreting *P. caespitosa* as a taller, open-growing species of lower elevations, primarily in *Pinus ponderosa* woodland and savanna.

Wherry (1962, 1965a, 1965b, 1969) took exception with these revisions, considering *P. condensata* and *P. pulvinata* mere high altitude expressions or "ecads" of *P. caespitosa*. However, the ecological divergence of these alpine/subalpine entities from *P. caespitosa* is pronounced, and, following Cronquist, *P. condensata* and *P. pulvinata* are recognized here as separate species.

1. Plant a subshrub, sparingly and diffusely branched, forming open tufts 5–15 cm tall, the erect-ascending flowering branches 2.5–7.7 cm long, with internodes typically apparent; associated with montane woodland, savanna and grassland **Phlox caespitosa**
1. Plant a caespitose perennial herb, growth habit pulvinate, forming more or less compact mats or cushions 2–7.5 cm tall, the flowering shoots 1–3(–5) cm long; associated with alpine or upper subalpine ecological systems.
   2. Plants forming dense, tight cushions, shoots closely packed together; leaves appressed, erect, 5–10 mm long; corolla-tube 6–10 mm long, lobes 3–5 mm long; styles 1.5–3 mm long **Phlox condensata**
   2. Plants forming loose, open cushions, shoots more spreading; leaves not appressed to stem, 6–12 mm long; corolla dimensions larger, the tube 7–14 mm long, lobes 6–7 mm long; styles 2.5–5.5 mm long **Phlox pulvinata**

While bringing this helpful clarification to the *P. caespitosa* complex, Cronquist (1959) unfortunately added confusion by reducing the name *P. douglasii* to synonymy under *P. caespitosa*. These are recognized here as separate species (see discussion of *P. douglasii* that follows).

As circumscribed here, *P. caespitosa* is a species of the Rocky Mountain System, chiefly in the Northern Rocky Mountains in southeastern British Columbia, northern Idaho, and western Montana. It occurs most abundantly in Montana, particularly on the eastern slope of the Bitterroot Mountains and in the intermountain valleys of the Rocky Mountain Trench. It occurs at lower to middle elevations (mostly 800–1500 m, but up to 2040 m) in the piedmont and mountains, and in association with morainal features of river valleys. *Phlox caespitosa* is strongly associated with *Pinus ponderosa* woodland and savanna, but also is common in montane, foothill, and valley grasslands in the region where *Pseudoroegneria spicata*, *Festuca idahoensis*, and *Festuca campestris* are the chief graminoids.

Interpreting floristic and ecological literature in relation to *P. caespitosa* is made difficult by the confused nomenclature surrounding this plant, particularly in connection with the name *P. douglasii* (discussed below), but with added problems coming from the literature of alpine ecology where the name *P. caespitosa* has been misapplied to *P. condensata* and *P. pulvinata*. Literature pertaining to *P. caespitosa* includes these: Lackschewitz 1991; Lesica 2002; Root & Habeck 1972 (as *P. pulvinata*); Shaw & On 1979.

CIRCUMSCRIPTION OF *PHLOX DOUGLASII* HOOK.

Hooker (1838) described *P. douglasii* in his *Flora Boreali-Americana*. As one of the first of the small-leaved cushion-forming phloxes described from western North America, the name *P. douglasii* subsequently served as catch-all for many later-discovered, superficially similar species, a number of which were treated as varieties or subspecies of *P. douglasii* at some point in their nomenclatural histories, including *P. andicola*, *P. austromontana*, and *P. diffusa*. Further confusion was caused by the emergence of the term "Douglasii Hybrids" in horticultural literature in the early 1900s, which was applied to a wide variety of cushion phlox cultivars of probable hybrid origin. Wherry brought much needed clarity to this situation through his papers on the western phloxes (1938, 1941) and his 1955 monograph in which he recognized *P. douglasii* as a distinct species with a distribution centered on the Columbia Plateau in the Pacific Northwest.

Cronquist (1959) reduced *P. douglasii* to synonymy under *P. caespitosa*, justifying this treatment under his discussion of *P. pulvinata* which he separated from *P. caespitosa*. Cronquist described the type of *P. caespitosa* as "a compact plant of the taxon usually known as *P. douglasii*." Since the name *P. caespitosa* was published by Nuttall (1834) four years before Hooker (1838) published *P. douglasii*, Cronquist reasoned that "the latter name [*P. douglasii*]...must subside."

Wherry (1962, 1965a) considered this "a serious misunderstanding," calling *P. douglasii* and *P. caespitosa* "about as distinct species as can exist among the Microphloxes." Indeed, Wherry (1955) placed these two species in independent subsections of the genus—*Douglasianae* and *Caespitosae*. Despite Wherry's protests, most subsequent floristic and ecological workers in the Pacific Northwest have followed Cronquist. Based on examination of the type material of both *P. douglasii* (HOLOTYPE: K, digital image!; ISOTYPES: BM, digital image! GH! NY, internet image! PH, digital image!) and *P. caespitosa* (HOLOTYPE: BM, digital image!; ISOTYPES: GH! NY, internet image! PH, digital image!), plus study of these entities in the field (*P. douglasii* in Washington, Oregon, and California; *P. caespitosa* in Montana), they are recognized here as separate species. As noted by Wherry (1962, 1965a, 1969), the leaves of *P. douglasii* are dark green, slender and needle-shaped (acicular or acerose), and covered by long gland-tipped hairs, while the leaves of *P. caespitosa* are pale green, relatively broad and flat (linear-oblong), thickish, and bear coarse glandless cilia along the margins. The distribution of *P. douglasii* is centered on the Columbia Plateau, while that of *P. caespitosa* is centered in the Northern Rocky Mountains.

Interpreting floristic and ecological literature in relation to *P. douglasii* is made difficult by the confused nomenclature surrounding this species. Prior to Cronquist (1959), this taxon was treated as *P. douglasii* or *P. rigida*, the latter recognized by Wherry (1938, 1955) as a reduced expression of the former under the name *P. douglasii* subsp. *rigida*. Following Cronquist's revisions, most workers abandoned these names in favor of *P. caespitosa*. Literature pertaining to *P. douglasii* includes these: Applegate 1938; Culver 1964 (as *P. diffusa*); Daubenmire & Daubenmire 1968 (as *P. caespitosa*); Driscoll 1964a, 1964b; Eckert 1957 (as *P. diffusa*); Hall 1967; Howell 1903; Munz & Keck 1959 (as *P. douglasii* subsp. *rigida*); Peck 1941; Piper 1906 (as *P. rigida*); Piper & Beattie 1914 (as *P. rigida*); St. John 1937 (as *P. douglasii* var. *rigida*). The following key separates *P. douglasii* from *P. caespitosa* and, additionally, from *P. diffusa*, a similar-appearing species that occurs in range.

1. Leaves pale green, relatively broad (linear-oblong) and flat, thickish, with coarse glandless cilia; Northern and Middle Rocky Mountains _____ **Phlox caespitosa**
1. Leaves dark or bright green, relatively narrow and slender, cilia lacking or fine; mostly west of the Rocky Mountains.
   2. Pubescent with glandular hairs throughout; leaves somewhat acicular (needle-shaped) and stiff, their surfaces pilose to glabrate with fine gland-tipped hairs; primarily dry to xeric habitat on the Columbia Plateau _____ **Phlox douglasii**
   2. Pubescence not glandular; leaves linear (narrow with sides parallel over most of length) to linear-subulate and only moderately rigid; primarily moderate to high elevations along the Cascade/Sierra axis _____ **Phlox diffusa**

CIRCUMSCRIPTION OF *PHLOX MISSOULENSIS* WHERRY

Wherry (1944) described *P. missoulensis* from the type collected by Merton J. Reed in 1939 on Waterworks Hill near Missoula, Montana (HOLOTYPE: PH, digital image!). Cronquist (1959) reduced this entity to *P. kelseyi* var. *missoulensis*, a relationship and reduction with which Wherry (1962, 1965b) strongly disagreed, calling *P. missoulensis* "a striking endemic...wholly unrelated" to *P. kelseyi*. In her thesis on the *P. kelseyi* complex, Campbell (1992) followed Cronquist in treating *P. missoulensis* as a variant of *P. kelseyi* (proposing but not publishing *P. kelseyi* subsp. *missoulensis*), but cited "extremely different habitats" plus "complete geographical isolation coupled with differences in 10 morphological characters" in support of recognition of *missoulensis* as a distinct entity within the *P. kelseyi* complex. *Phlox missoulensis* and *P. kelseyi* are recognized here as separate species (see key below). *Phlox missoulensis* is endemic to the Northern Rocky Mountains in west-central Montana, chiefly along or just west of the Continental Divide where it occurs in the Anaconda, Garnet, Lewis and Clark, and Sapphire ranges and on small mountains in the vicinity of Missoula, with outlying occurrences east of the Continental Divide in the Little Belt Mountains.

Leaves dark green, linear to linear-lanceolate, thinnish but with subacerose tip, ciliate and surficially pilose with fine gland-tipped hairs; exposed mountain slopes and ridges; habitat dry to xeric; soils stony and shallow _____ **Phlox missoulensis**

Leaves pale green, linear-lanceolate, acuminate and cuspidate, thickish and succulent, fleshy (becoming wrinkly on drying), the margin slightly thickened, basally coarse-ciliate, surficially glabrous to moderately pubescent; mountains valleys and intermountain basins and flats; habitat seasonally moist to wet; soils alluvial, fine-textured, alkaline to highly-alkaline _____ **Phlox kelseyi**

ACKNOWLEDGEMENTS

The author wishes to acknowledge the curators and staff of the following herbaria for the loan of specimens and/or providing images and label data from specimens: ALA, BM, CAN, K, MONTU, OKLA, PH, RSA-POM, WS. Robert Kaul, curator of NEB, was especially helpful in securing these loans. Thanks also to the curators of BRIT, GH, RM, TEX/LL, US for access to their collections. This work has benefited greatly from conversations with Carolyn Ferguson. Finally, thanks to anonymous reviewers as well as Andrew Hipp, Barney Lipscomb, Tony Reznicek, and Guy Nesom for valuable review and helpful comments on the manuscript.

REFERENCES

Aiken, S.G., M.J. Dallwitz, L.L. Consaul, C.L. McJannet, L.J. Gillespie, R.L. Boles, G.W. Argus, J.M. Gillett, P.J. Scott, R. Elven, M.C. LeBlanc, A.K. Brysting, and H. Solstad. 1999 and onwards. Flora of the Canadian Arctic Archipelago: descriptions, illustrations, and information retrieval. Version: 29th April 2003. http://www.mun.ca/biology/delta/arcticf/'.

Applegate, E.I. 1938. Plants of the lava beds National Monument, California. Amer. Midl. Naturalist 19 (2): 334–368.

Bailey, D. K. 1970. Phytogeography and taxonomy of *Pinus* subsection *Balfourianae*. Ann. Missouri Bot. Gard. 57:210–249.

Baker, W.L. 1983. Alpine vegetation of Wheeler Peak, New Mexico, U.S.A: gradient analysis, classification, and biogeography. Arctic Alpine Res. 5:223–240.

Balandin, S.A. and V.Y. Razzhivin. 1980. The influence of snow cover on the distribution of vegetation in the southeast of Chukotka Peninsula. Bot. Zhurn. 71:1088–1097. [In Russian, with summary in English]

Billings, W.D. and J.H. Thompson. 1957. Composition of a stand of old bristlecone pines in the White Mountains of California. Ecology 38:158–160.

Botti, S.J. and W. Sydoriak. 2001. An illustrated flora of Yosemite National Park. Yosemite Association, El Portal, California.

Boyce, R.L., R. Clark, and C. Dawson. 2005. Factors determining alpine species distribution on Goliath Peak, Front Range, Colorado, U.S.A. Arctic Alpine Res. 37:88–96.

Brand, A. 1907. Polemoniaceae. Das Pflanzenreich. Leipzig: Wilhelm Engelmann. 4(250):1–203.

Campbell, L.M. 1992. Biosystematics of *Phlox kelseyi* (Polemoniaceae). M.S. thesis, University of Montana, Missoula.

Carlson, M., H. Cortes-Burns, L. Flagstad, and R. Lipkin. 2006a. Rare vascular plant species of the North Slope: a review of taxonomy, distribution and ecology of 33 rare plant taxa that occur in Alaska's North Slope region. Final report for the Bureau of Land Management, Northern Field Office, Fairbanks, Alaska.

Carlson, M.L., R. Lipkin, H. Cortes-Burns, and I.V. Lapina. 2006b. Stewart River training area—rare plant survey—2006. Alaska Natural Heritage Program, Anchorage, Alaska; prepared for the Alaska Army National Guard, State of Alaska Department of Military and Veteran Affairs, Fort Richardson, Alaska.

Chabot, B.F. and W.D. Billings. 1972. Origins and ecology of the Sierran alpine flora and vegetation. Ecol. Monogr. 42:163–199.

Clokey, I.W. 1951. Flora of the Charleston Mountains, Clark County, Nevada. Univ. Calif. Publ. Bot. 24:1–274.

Cockerell, W.P. 1903. A trip to the Truchas Peaks, New Mexico. Amer. Naturalist 37887–891.

Cook, M.B. and C.A. Roland. 2002. Notable vascular plants from Alaska in Wrangell-St. Elias National Park and Preserve with comments on the floristics. Canad. Field-Naturalist 116:192–304.

Cooper, D.J. 1989. Geographical and ecological relationships of the arctic-alpine vascular flora and vegetation, Arrigetch Peaks region, central Brooks Range, Alaska. J. Biogeogr. 16:279–295.

Cox, C.F. 1933. Alpine plant succession on James Peak, Colorado. Ecol. Monogr. 3:299–372.

Cronquist, A. 1959. *Phlox*. In: Vascular plants of the Pacific Northwest. C.L. Hitchcock, A. Cronquist, M. Ownbey, and J.W. Thompson, eds. University of Washington Press, Seattle, Washington. Pp. 124–137.

Cronquist, A. 1984. *Phlox*. In: Intermountain Flora, volume 4. A. Cronquist, A.H. Holmgren, N.H. Holmgren, J.L. Reveal, and P.K. Holmgren, eds. The New York Botanical Garden, Bronx, New York. Pp. 95–107.

Culver, R.N. 1964. An ecological reconnaissance of the *Artemisia* steppe on the east central Owyhee uplands of Oregon. MS Thesis, Oregon State University.

Curtis, W. 1798. *Phlox setacea.* Fine-leaved phlox. Bot. Mag. 12: plate 415.

Daubenmire, R. and J. B. Daubenmire. 1968. Forest vegetation of eastern Washington and northern Idaho. Washington Agric. Exp. Sta. Tech. Rep. 60:1–104.

Drew, J.V. and R.E. Shanks. 1965. Landscape relationships of soils and vegetation in the forest-tundra ecotone, Upper Firth River Valley, Alaska-Canada. Ecol Monogr. 35:285–306.

Driscoll, R.S. 1964a. A relict area in the central Oregon juniper zone. Ecology 45:345–353.

Driscoll, R.S. 1964b. Vegetation-soil units in the central Oregon juniper zone. USDA Forest Service Research Paper PNW-19, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Eckert, R.E., Jr. 1957. Vegetation-soil relationships in some *Artemisia* types in northern Harney and Lake counties, Oregon. PhD Thesis, Oregon State University.

Ermakov, N., M. Cherosov, and P. Gogoleva. 2002. Classification of ultracontinental boreal forests in central Yakutia. Folia Geobot. 37:419–440.

Ermakov, N., B. Chytry, and M. Valachovic. 2006. Vegetation of the rock outcrops and screes in the forest-steppe and steppe belts of the Altai and Western Sayan Mts., southern Siberia. Phytocoenologia 36:509–545.

Ferguson, C.J. 1998. Molecular systematics of eastern *Phlox* L. (Polemoniaceae). PhD Thesis, University of Texas at Austin.

Ferguson, C.J. and R.K. Jansen. 2002. A chloroplast DNA phylogeny of eastern *Phlox* (Polemoniaceae): implications of congruence and incongruence with the ITS phylogeny. Amer. J. Bot. 89:1324–1335.

Ferguson, C.J., F. Kramer, and R.K. Jansen. 1999. Relationships of eastern North American *Phlox* (Polemoniaceae) based on ITS sequence data. Syst. Bot. 24:616–631.

Freedman, B., V. Zobens, T.C. Hutchinson, and W. I. Gizyn. 1990. Intense, natural pollution affects arctic tundra vegetation at the Smoking Hills, Canada. Ecology 71:492–503.

Goodrich, S. and E. Neese. 1986. Uinta Basin Flora. U.S.D.A. Forest Service Intermountain Region, Ogden, Utah.

Gray, A. 1870. Revision of the North American Polemoniaceae. Proc. Amer. Acad. Arts 8:247–282.

Grubov, V.I. 2001. Key to the vascular plants of Mongolia (with an atlas). Science Publishers, Inc., Enfield, New Hampshire.

Hall, F.C. 1967. Vegetation-soil relations as a basis for resource management on the Ochoco National Forest of central Oregon. PhD Thesis, Oregon State University.

Hanson, H.C. 1951. Characteristics of some grassland, marsh, and other plant communities in western Alaska. Ecol. Monogr. 21 (4):317–378.

Hartman, E.L. and M.L. Rottman. 1985. The alpine vascular flora of the Mt. Bross Massif, Mosquito Range, Colorado. Phytologia 57:133–151.

Hartman, E.L. and M.L. Rottman. 1988. The vegetation and alpine vascular plant flora of the Sawatch Range, Colorado. Madroño 35:202–225.

Hartman, J. and R. Mitchell. 1979. Plants of Mount Goliath Research Natural Area. Prairie Naturalist 11:39–48.

Holm, T. 1922. Contributions to the morphology, synonymy, and geographical distribution of arctic plants. Report of the Canadian Arctic Expedition 1913–18, 5 (B):1–139. F.A. Acland, Ottawa, Canada.

Hooker, W.J. [1829-]1833–1840. Flora Boreali-Americana; or, the botany of the northern parts of British North America.... 2 volumes, in 12 parts. London, Paris, and Strasbourg.

Howell, T. 1903. A flora of Northwest America. Volume 1. Phanerogamae. Portland, Oregon.

Hulten, E. 1948. Flora of Alaska and Yukon. Acta Univ. Lund. Bd 4 (pt. 8):1202–1341.

Hulten, E. 1968. Flora of Alaska and neighboring territories: a manual of the vascular plants. Stanford University Press, Stanford, California.

Hutchinson, I.W. 1934. North to the rime-ringed sun: being the record of an Alaskan-Canadian journey made in 1933–34. Blackie & Son Limited, London.

Johansen, F. 1924. General observations on the vegetation. Report of the Canadian Arctic Expedition 1913–18, 5 (C):1–85. F.A. Acland, Ottawa, Canada.

Johnson, A.W., L.A. Viereck, R.E. Johnson, and H. Melchior. 1966. Vegetation and flora. In: Environment of the

Cape Thompson Region, Alaska. N.J. Wilimovsky and J.N. Wolfe, eds. United States Atomic Energy Commission,Washington, D.C.. Pp. 277–354.

Jordal, L.H. 1952. Some new entities in the flora of the Brooks Range, Alaska. Rhodora 54:35–39.

Juday, G.P. 1989. Alaska Research Natural Areas. 2: Limestone Jags. Gen. Tech. Rep. PNW-GTR-237. Portland, Oregon: U.S.D.A., Forest Service, Pacific Northwest Research Station.

Kartesz, J.T. 1988. A flora of Nevada. PhD Thesis, University of Nevada.

Kelso, S. 1987. *Primula anvilensis* (Primulaceae): a new species from northwestern Alaska. Syst. Bot. 12 (1):9–13.

Kelso, S. 1989. Vascular flora and phytogeography of Cape Prince of Wales, Seward Peninsula, Alaska. Canad. J. Bot. 67:3248–3259.

Kelso, S. 1992. Conspectus of the genus *Douglasia* (Primulaceae) with comments on *Douglasia alaskana*, an Alaska – Yukon endemic. Canad. J. Bot. 70:593–596.

Kelso, S., B.A. Yurtsev, and D.F.Murray. 1994. *Douglasia beringensis* (Primulaceae): a new species from northwestern Alaska. Novon 4:381–385.

Kiener, W.B. 1967. Sociological studies of the alpine vegetation on Longs Peak. Univ. Nebraska Stud. No. 34.

Kimball, S., P. Wilson, and J. Crowther. 2004. Local ecology and geographic ranges of plants in the Bishop Creek watershed of the eastern Sierra Nevada, California, USA. J. Biogeogr. 31:1637–1657.

Knyaszev, M.S., S.A. Mamaev, and V.E. Vlasenko. 2007. Relict communities and populations of petrophilous plant species in northern regions of Sverdlovsk Oblast and problems in their conservation. Russ. J. Ecol. 38:317–322.

Krasheninnikov, I.M. 1937. Analysis of the relict flora of the Southern Urals in the context of vegetation history and paleogeography of the Pleistocene. Sovetskia botanika 4:16–45 [in Russian].

Krantz, T.P. 1994. A phytogeography of the San Bernardino Mountains, San Bernadino County, California. PhD Thesis, University of California at Berkeley.

Kuc, M. 1974. Noteworthy vascular plants collected in southwestern Banks Island, N.W.T. Arctic 27:146–150.

Kuc, M. 1996. Plant formations and their bio-products from the western Banks Island (N.W.T., Canada). Polarforschung 64:115–122.

Lackschewitz, K. 1991. Vascular plants of west-central Montana – identification guidebook. Gen. Tech. Rep. INT–277. U.S.D.A., Forest Service, Intermountain Region Station, Ogden, Utah.

Langenheim, J.H. 1962. Vegetation and environmental patterns in the Crested Butte Area, Gunnison County, Colorado. Ecol. Monogr. 32:249–285.

Lesica, P. 2002. A flora of Glacier National Park, Montana. Oregon State University Press, Corvallis, Oregon.

Levin, D.A. 1966. The *Phlox pilosa* complex: crossing and chromosome relationships. Brittonia 18:142–162.

Levin, D.A. 1968. The genome constituents of eastern North American *Phlox* amphiploids. Evolution 22: 612–632.

Levin, D.A. and B.A. Schaal. 1970. Reticulate evolution in *Phlox* as seen through protein electrophoresis. Amer. J. Bot. 57:977–987.

Levy, M. and D.A. Levin. 1971. The origin of novel flavinoids in *Phlox* allotetraploids. Proc. Natl. Acad. Sci. 68: 1627–1630.

Levy, M. and D.A. Levin. 1974. Novel flavonoids and reticulate evolution in the *Phlox pilosa-P. drummondii* complex. Amer. J. Bot. 61:156–167.

Linnaeus, C. 1753. Species Plantarum. Stockholm.

Linsdale, M.A., J.T. Howell, and J.M. Lisdale. 1952. Plants of the Toiyabe Mountains area, Nevada. Wasmann J. Biol. 10:129–200.

Lloyd, R.M. and R.S. Mitchell. 1973. A flora of the White Mountains, California and Nevada. University of California Press, Berkeley, California.

Locklear, J.H. *Phlox*. Timber Press, Portland, Oregon. (in press).

Loddiges, C. 1823. *Phlox nivalis*. Bot. Cab. 8: plate 780

Major, J. and D.W. Taylor. 1977. Alpine. In: Terrestrial vegetation of California. M.G. Barbour and J. Major, eds. Wiley-Interscience, New York. Pp. 602–675.

Marchand, D.E. 1973. Edaphic control of plant communities in the White Mountains, Eastern California. Ecology 54:233–250.

Macoun, J. M. and T. Holm. 1921. Report of the Canadian Arctic expedition, 1913–18. Volume 5: Botany, Part A: Vascular plants. Report of the Canadian Arctic Expedition 1913–18, 5 (A):1–50. F.A. Acland, Ottawa, Canada.

McKelvey, S.D. 1955. Botanical exploration of the Trans-Mississippi West, 1790–1850. Arnold Arboretum of Harvard University, Jamaica Plain, Massachusetts.

Mirkin, B.M., P.A. Gogoleva, and K.E. Kononov. 1985. The vegetation of central Yacutian Alases. Folia Geobot. Phytotax. 20:345–395.

Mooney, H.A., G. St. Andre, and R.D. Wright. 1962. Alpine and subalpine vegetation patterns in the White Mountains of California. Amer. Midl. Naturalist 68:257–273.

Muir, J. 1917. The cruise of the Corwin: journal of the Arctic Expedition of 1881 in search of the De Long and the Jeannette. Houghton Mifflin Company, Boston, Massachusetts.

Munz, P.A. 1974. A flora of Southern California. Berkeley, California: University of California Press.

Munz, P.A. and D.D. Keck. 1959. A California flora. University of California Press, Berkeley, California.

Nelson, A. and P.B. Kennedy. 1906. Plantae Montrosensis I. Proc. Biol. Soc. Wash. 19:35–40.

Nelson, E.E. 1899. Revision of the western North American phloxes. Contr. Dept. Bot. Rocky Mountain Herb. 27:1–35.

Nuttall, T. 1834. A catalogue of a collection of plants made chiefly in the valleys of the Rocky Mountains or Northern Andes, towards the sources of the Columbia River, by Mr. Nathaniel B. Wyeth, and described by T. Nuttall. J. Acad. Nat. Sci. Philadelphia 7:5–60.

Patterson, R.W. and D.H. Wilken. 1993. *Phlox*. In: The Jepson manual: higher plants of California. J.C. Hickman, ed. University of California Press, Berkeley, California. Pp. 849–850.

Peck, M.E. 1941a. A manual of the higher plants of Oregon. Binfords & Mort, Portland, Oregon.

Peinado, M., J.L. Aguirre, J. Delgadillo, and J. Martinez-Parras. 2005. A phytosociological survey of the chionophilous communities of western North America. Part I: temperate and Mediterranean associations. Pl. Ecol. 180:187–241.

Pemble, R.H. 1970. Alpine vegetation in the Sierra Nevada of California as lithosequences and in relation to local site factors. PhD Thesis, University of California, Davis.

Peshkova, G.A. 1972. Steppe flora of Lake Baikal in Siberia. Moskva: Nauka. [in Russian]

Peshkova. G.A. 2001. Florogenetic analysis of the steppe flora of southern Siberian Mountains. Novosibirsk: Nauka. [in Russian]

Piper, C.V. 1906. Flora of the state of Washington. Contr. U.S. Natl. Herb. 11:1–637.

Piper, C.V. and R.K. Beattie. 1914. Flora of southeastern Washington and adjacent Idaho. New Era Printing, Lancaster, Pennsylvania.

Plukenet, L. 1691. Phytographia. London.

Porsild, A.E. 1939a. Contributions to the flora of Alaska. Rhodora 41:141–183.

Porsild, A.E. 1939b. Contributions to the flora of Alaska. Rhodora 41:262–301.

Porsild, A.E. 1972. The vascular flora of Limestone Hills, northern extension of the Ogilvie Mountains, Yukon Territory. Arctic 25:233–236.

Razzhivin, V.Y. 1986. The effect of soil reaction on the plant distribution of snowbed plant communities of the southeasternmost Chukotka peninsula. Bot. Zhurn. 71:1088–1097. [in Russian]

Razzhivin, V.Y. 1994. Snowbed vegetation of far northeastern Asia. J. Veg. Sci. 5:829–842.

Reveal, J.L., C.R. Broome, M.L. Brown, and G.F. Frick. 1982. Comments on the typification of two Linnaean species of *Phlox* (Polemoniaceae). Taxon 31:733–736.

Root, R.A. and J.R. Habeck. 1972. A study of high elevation grassland communities in western Montana. Amer. Midl. Naturalist 87:109–121.

St. John, H. 1937. Flora of southeastern Washington and of adjacent Idaho. Pullman, Washington: Students Book Corporation.

Sharsmith, C.W. 1940. A contribution to the history of the alpine flora of the Sierra Nevada. PhD Thesis, University of California.

Shaw, R.J. and D. On. 1977. Plants of the Waterton-Glacier National Parks and the Northern Rockies. Mountain Press Publishing, Missoula, Montana.

Shepherd, H.R. 1975. Vegetation of two dissimilar bighorn sheep ranges in Colorado. Colorado Division of Wildlife Division Report 4:1–223.

Shetler, S.G. 1963. An annotated list of vascular plants from Cape Sabine, Alaska. Rhodora 65:208–224.

Small, J.K. 1903. Flora of the southeastern United States. Published by the author. New York.

Smith, D.M. and D.A. Levin. 1967. Karyotypes of eastern North American *Phlox*. Amer. J. Bot. 54:324–334.

Sochava, V.B. 1945. Fragments of mountain steppe in the Middle Urals. Sovetskia Botanika 13:28–37. [in Russian]

Spetzman, L.A. 1959. Vegetation of the Arctic Slope of Alaska. U.S. Geological Survey Professional Paper 302-B.

Spira, T.P. 1991. Plant zones. In: Natural history of the White-Inyo Range, eastern California. C.A. Hall, Jr., ed. University of California Press, Berkeley. Pp. 77–86.

Sweet, R. 1827. *Phlox nivalis*. Brit. Fl. Gard. 2: plate 185.

Taylor, R.J. and C.E.S. Taylor. 1981. *Phlox pilosa* var. *longipilosa* (Waterfall) J. & C. Taylor comb. nov. (Polemoniaceae). Sida 9:183–184.

Turner, B.L. 1998. Atlas of the Texas species of *Phlox* (Polemoniaceae). Phytologia 85:309–326.

Walker, D.A., E. Binnian, B.M. Evans, N.D. Lederer, E. Nordstrand, and P.J. Webber. 1989. Terrain, vegetation and landscape evolution of the R4D research site, Brooks Range Foothills, Alaska. Holarc. Ecol. 12:238–261.

Walker, M.D., D.A. Walker, K.R. Evert, and S.K. Short. 1991. Steppe vegetation of south-facing slopes of pingos, central Arctic Coastal Plain, Alaska. Arctic Alpine Res. 23:170–188.

Walker, M.D., D.A. Walker, and N.A. Auerbach. 1994. Plant communities of a tussock tundra landscape in the Brooks Range Foothills, Alaska. J. Veg. Sci. 5:843–866.

Waterfall, U.T. 1971. New species of *Cuscuta* and *Phlox* from Oklahoma. Rhodora 73:575–577.

Weber, W.A. and R.C. Wittmann. 2001a. Colorado flora: eastern slope, edition 3. University Press of Colorado, Boulder, Colorado.

Weber, W.A. and R.C. Wittmann. 2001b. Colorado flora: western slope, edition 3. University Press of Colorado, Boulder, Colorado.

Welsh, S. L. 1985. Revision of the *Phlox austromontana* (Polemoniaceae) complex in Utah. Great Basin Naturalist 45:791–792.

Wenk, E.H. and T.E. Dawson. 2007. Interspecific differences in seed germination, establishment, and early growth in relation to preferred soil type in an alpine community. Arctic Alpine Res. 39:165–176.

Wherry, E.T. 1929. The eastern subulate-leaved phloxes. Bartonia 11:5–35, plates 1–4.

Wherry, E.T. 1937. Synonyms and variety names for *Phlox nivalis*. Gard. Chron. Amer. 41:212–213.

Wherry, E.T. 1938. The phloxes of Oregon. Proc. Acad. Nat. Sci. Philadelphia 90:133–140.

Wherry, E.T. 1939. Four southwestern subspecies of *Phlox*. J. Wash. Acad. Sci. 29:518–519.

Wherry, E.T. 1941. The phloxes of Idaho. Notul. Nat. Acad. Nat. Sci. Philadelphia 87:1–15.

Wherry, E.T. 1942. The phloxes of Nevada. Notul. Nat. Acad. Nat. Sci. Philadelphia 113:1–11.

Wherry, E.T. 1944. New phloxes from the Rocky Mountains and neighboring regions. Notul. Nat. Acad. Nat. Sci. Philadelphia 146:1–11.

Wherry, E.T. 1955. The genus *Phlox*. The Morris Arboretum of the University of Pennsylvania, Philadelphia, Pennsylvania.

Wherry, E.T. 1956. Validation of new combinations in *Phlox*. Baileya 4:5–7.

Wherry, E.T. 1962. A controversial treatment of the Polemoniaceae. Madrono 16:270–271.

Wherry, E.T. 1965a. Relationships of *Phlox caespitosa*, *pulvinata*, and *douglasii* (Polemoniaceae). Sida 2:154–156.

Wherry, E.T. 1965b. The genus *Phlox*, ten years after. Bartonia 35:13–16.

Wherry, E.T. 1966. Polemoniaceae. In: Flora of Texas, volume 1. C.L. Lundell, ed. Texas Research Foundation, Renner, Texas. Pp. 283–321.

Wherry, E.T. 1969. *Phlox* and *Polemonium* (Polemoniaceae) in the Intermountain Region. Sida 3:441–444.

Whitehouse, E. 1935. Notes on Texas phloxes. Bull. Torrey Bot. Club 62:381–386.

Wooton, E.O. and P.C. Standley. 1915. Flora of New Mexico. Contr. U.S. Natl. Herb. 19:1–794.

Wright, R.D. and H.A. Mooney. 1965. Substrate-oriented distribution of bristlecone pine in the White Mountains of California. Amer. Midl. Naturalist 73:257–284.

Yurtsev, B.A. 1963. On the floristic relations between steppes and prairies. Bot. Not. 116:396–408.

Yurtsev, B.A. 1967. Phytogeographical investigations in the western and central parts of the Chukotsk Peninsula, 1964–1966. Bot. Zhurn. 52:1031–1043. [in Russian]

Yurtsev, B.A. 1972. Phytogeography of northeastern Asia and the problem of Transberingian floristic interrelations. In: Floristics and paleofloristics of Asia and eastern North America. A. Graham, ed. Elsevier Publishing Company, Amsterdam, Netherlands. Pp. 19–54.

Yurtsev, B.A. 1994. Floristic divisions of the Arctic. J. Veg. Sci. 5:765–776.

VALIDATION OF THE NAME *SYMPLOCOS PENTANDRA* (SYMPLOCACEAE)

João Luiz M. Aranha Filho
Department of Plant Biology
University of Campinas
C.P. 6109, CEP 13083-970, Campinas, SP, BRAZIL
aranhafilho@gmail.com

Peter W. Fritsch and Frank Almeda
Department of Botany
California Academy of Sciences
55 Music Concourse Drive
San Francisco, California 94118-4503, U.S.A.
pfritsch@calacademy.org; falmeda@calacademy.org

Angela B. Martins
Department of Plant Biology
University of Campinas
C.P. 6109, CEP 13083-970, Campinas, SP, BRAZIL
amartins@unicamp.br

ABSTRACT

We validate the name **Symplocos pentandra** (Mattos) Occhioni (*Symplocos* section *Barberina* (Vell.) A. DC., Symplocaceae), a name not validly published in 1974 because when it was raised to the rank of species the basionym was not fully cited. The name *S. pentandra* represents a new combination and new status for the entity originally described as *S. itatiaiae* Wawra var. *pentandra* Mattos.

Key Words: Brazil, nomenclature, Symplocaceae, *Symplocos*

RESUMO

Nós validamos o nome **Symplocos pentandra** (Mattos) Occhioni (*Symplocos* seção *Barberina* (Vell.) A. DC., Symplocaceae), um nome não validamente publicado em 1974, já que quando foi elevado ao nível de espécie o basiônimo não foi completamente citado. O nome *S. pentandra* representa uma nova combinação e um novo status para a entidade originalmente descrita como *S. itatiaiae* Wawra var. *pentandra* Mattos.

Palavras Chave: Brasil, nomenclatura, Symplocaceae, *Symplocos*

Symplocos section *Barberina* (Vell.) A. DC. (sensu Fritsch et al. 2008) comprises ca. 25 species distributed in eastern Asia and the Americas. Species within this section are recognized by their hermaphroditic or dioecious breeding system, basally connate corolla, stamens that are adnate to the corolla only at the base, terete filaments that are either distinct or united only at the base, 3-carpellate ovary, 1–(2–3) locular fruit with 1(2–3) seeds, and an embryo with the radicle usually longer than the cotyledons (rarely shorter; Brand 1901; Fritsch et al. 2008). One of the species within this section is the Brazilian endemic *Symplocos pentandra* (Mattos) Occhioni. This species was originally described as a variety of *S. itatiaiae* Wawra by Mattos (1971) and subsequently raised to species rank by Occhioni (1974). Specimens of this species are housed in many herbaria and the name *S. pentandra* is commonly used in publications on the flora of Brazil (e.g., Sobral et al. 2006).

In the course of revising the South American species of sect. *Barberina* we have agreed with Occhioni (1974) that *S. pentandra* should be treated as a species and not a variety of *S. itatiaiae*. Therefore, we accept *S. pentandra* in our treatment. When raising *S. itatiaiae* var. *pentandra* to species rank, however, Occhioni (1974) did not indicate the page where it was validly published and therefore did not fully cite the reference of the basionym. Thus, under article 33.4 of the *International Code of Botanical Nomenclature* (ICBN; McNeill et al. 2006), *S. pentandra* cannot be considered a validly published name. In his unpublished revision of the Brazilian species of Symplocaceae, Bidá (1995) suggested that Occhioni's name *S. pentandra* can be treated as a validly published new species because Occhioni provided a holotype that was different than that of *S. itatiaiae* var. *pentandra* and described the plant in Latin. It is clear, however, that Occhioni intended to raise *S. itatiaiae* var. *pentandra* to the species rank, because of the author citation "*Symplocos pentandra* (Mattos)

Occhioni, stat. nov." Nonetheless, due to his omission in providing the page where the basionym was validly published and his direct reference to the basionym work, *S. pentandra* is consequently still not validly published. This is because, according to the article 33.8 of the ICBN, on and after 1 January 1953 if an author claims to be publishing a new combination but fails to provide all the requirements under article 33.4 the name is not validly published even if the author provided at the same time other information that would have resulted in valid publication as the name of a new taxon (McNeill et al. 2006).

We also studied specimens identified as *S. caparaoensis* by Schwacke, which has been considered a validly published name (e.g., Mattos 1969) and cited as *S. caparaoensis* Schwacke ex Gürke. Our observations of these specimens suggest that *S. caparaoensis* makes reference to the same entity as *S. pentandra*. However, Gürke (1891) provided neither diagnosis nor illustration with analysis for *S. caparaoensis*, which is therefore a nomen nudum. Thus, *S. caparaoensis* is not validly published under articles 32.1(d) and 42.3 of the ICBN, respectively (McNeill et al. 2006).

We here validate the name *S. pentandra*. We choose to validate this name instead of *S. caparaoensis* because *S. pentandra* is based on a validly published name.

Symplocos pentandra (Mattos) Occhioni ex Aranha, comb. et stat. nov. BASIONYM: *Symplocos itatiaiae* Wawra var. *pentandra* Mattos ["*Symplocos itatiaiae* Wawra var. *pentrandra* Mattos"], Loefgrenia 54:1. 1971. TYPE: BRAZIL. PARANÁ: Piraquara, Florestal, 930 m, 7 Nov 1946, *G. Hatschbach 358* (HOLOTYPE: MBM; ISOTYPES: PACA, SP!).

ACKNOWLEDGMENTS

The first author is grateful to Conselho Nacional do Desenvolvimento Científico e Tecnológico (CNPq) for a Ph.D. grant and the Lakeside Foundation for support during a six-month research visit to the California Academy of Sciences.

REFERENCES

BIDÁ, A. 1995. Revisão taxonômica das espécies de *Symplocos* Jacq. (Symplocaceae) do Brasil. Unpublished Ph.D. thesis. Universidade de São Paulo, SP, Brazil.

BRAND, A. 1901. Symplocaceae. In: A. Engler, ed. Das Pflanzenreich, IV.242 (Heft 6):1–100. Engelmann, Lipsia, Germany.

FRITSCH, P.W., L.M. KELLY, Y. WANG, F. ALMEDA, AND R. KRIEBEL. 2008. Revised infrafamilial classification of Symplocaceae based on phylogenetic data from DNA sequences and morphology. Taxon 57:823–852.

GÜRKE, M. 1981. Symplocaceae. In: A. Engler and K. Prantl, eds. Nat. Pflanzenfam., Vol. 4(1):165–172. F. Fleisher, Lipsia, Germany.

MATTOS, J.R. 1969. Observações sobre Symplocaceae. Arq. Bot. Estado São Paulo 4:269–272.

MATTOS, J.R. 1971. Novidades taxonômicas. Loefgrenia 54:1–2.

MCNEILL, J., F.R. BARRIE, H.M. BURDET, V. DEMOULIN, D.L. HAWKSWORTH, K. MARHOLD, D.H. NICOLSON, J. PRADO, P.C. SILVA, J.E. SKOG, J.H. WIERSEMA, AND J. TURLAND. 2006. International code of botanical nomenclature (Vienna Code). A.R.G. Ganter Verlag KG, Ruggell, Liechtenstein.

OCCHIONI, P. 1974. As espécies de Symplocaceae da flora do Paraná. Leandra 4–5:31–52.

SOBRAL, M., J.A. JARENKOW, P. BRACK, B. IRGANG, J. LAROCCA, AND R.S. RODRIGUES. 2006. Flora arbórea e arborescente do Rio Grande do Sul, Brasil. Rima Editora e Novo Ambiente Editora, São Carlos, Brazil.

CLARIFICATIONS CONCERNING THE NOMENCLATURE AND TAXONOMY OF *OXYPOLIS TERNATA* (APIACEAE)

Mary Ann E. Feist

Department of Plant Biology
University of Illinois at Urbana-Champaign
Urbana, Illinois 61801, U.S.A.
mfeist@illinois.edu

ABSTRACT

John R. Edmondson made the combination *Oxypolis denticulata* (Baldwin) J.R. Edm. based on the assumption that *Sium denticulatum* Baldwin was synonymous with *O. ternata* (Nutt.) A. Heller. An in-depth investigation into the taxonomic and nomenclatural history of these species has shown, however, that *S. denticulatum* Baldwin and *O. ternata* (Nutt.) A. Heller are not synonyms. In addition, the name *O. denticulata* (Baldwin) J.R. Edm. is an isonym of *O. denticulata* (Baldwin) Raf.

KEY WORDS: Apiaceae, isonym, *Oxypolis denticulata, Oxypolis rigidior, Oxypolis ternata, Peucedanum ternatum, Sium denticulatum*

RÉSUMÉ

John R. Edmondson hizo la combinación *Oxypolis denticulata* (Baldwin) J.R. Edm. de acuerdo con la suposición que *Sium denticulatum* Baldwin era un sinónimo de *O. ternata* (Nutt.) A. Heller. Una investigación detallada de la historia taxonómica y la nomenclatural de estos y de taxa relacionados sin embargo, ha demostrado que *S. denticulatum* Baldwin y *O. ternata* (Nutt.) A. Heller no son sinónimos. Además, el nombre *O. denticulata* (Baldwin) J.R. Edm. es un isónimo de *O. denticulata* (Baldwin) Raf.

In 2005, J.R. Edmondson published what he believed to be a new combination, *Oxypolis denticulata* (Baldwin) J.R. Edm., to include the names *Sium denticulatum* Baldwin, *Peucedanum ternatum* Nutt., and *O. ternata* (Nutt.) A. Heller. He argued that the name *O. denticulata* superseded *O. ternata*, the commonly cited modern name for this species. Further investigation into the nomenclatural and taxonomic history of these and related taxa has shown, however, that Edmondson made two important errors in proposing this combination: his name is an isonym, and *S. denticulatum* is not synonymous with *P. ternatum* and *O. ternata*.

In 1898, A. Heller transferred *Peucedanum ternatum* to *Oxypolis* and *O. ternata* became the commonly cited modern name for this species. Edmondson (2005) found an isotype of *Sium denticulatum* in the herbarium of the Linnean Society of London (LINN). He made the assumption that *P. ternatum* was synonymous with *S. denticulatum*. Since Heller's combination was based on Nuttall's (1818) epithet published after Baldwin's (Elliott 1817), Edmonson reasoned that the earlier name had priority and a new combination was warranted. Thus Edmondson proposed the combination *O. denticulata* and designated as the lectotype the LINN specimen (LINN-Smith no: 508.5) labeled "*Sium denticulatum* nov. sp." and collected by William Baldwin in 1817.

Edmondson went on to explain that when Rafinesque established the new genus *Oxypolis* (Rafinesque 1825), he included *Sium denticulatum* under *Oxypolis* but failed to make a new combination for the species. Edmondson was correct that Rafinesque did not make the new combination in 1825, but he overlooked that Rafinesque did make the combination five years later in the first volume of Bulletin Botanique (Bull. Bot. 1:218. 1830). Rafinesque's combination was clearly based on *S. denticulatum*, the same basionym upon which Edmondson based his combination. Consequently, the Edmondson isonym is without nomenclatural status and should be disregarded according to Article 6 Note 2 of the *International Code of Botanical Nomenclature* (McNeill et al. 2006).

The second error in Edmondson's combination was in assuming that *Sium denticulatum* was synonymous with *Peucedanum ternatum*, when in actuality, *S. denticulatum* is a synonym of *Oxypolis rigidior* (L.) Raf. The recognition of this synonymy is not unprecedented for in 1840 Torrey and Gray recognized *S. denticulatum* as a synonym of *S. rigidius* L., the basionym for *O. rigidior*.

J. Bot. Res. Inst. Texas 3(2): 661 – 666. 2009

The protologues for *Sium denticulatum* and *Peucedanum ternatum* provide the first clue that these species are not synonyms. Baldwin (Elliott 1817) described *S. denticulatum* as having "leaves unequally pinnate; leaflets oval, toothed, acute; … generally with three pairs of leaflets and an odd one." In contrast, Nuttall (1818) characterized *P. ternatum* as having: "leaves all ternate, upon very long common petioles; partial leaves entire, long, linear, acute, and attenuated below… perfectly entire and scarcely three lines wide."

Comparing the lectotype of *Sium denticulatum* (Fig. 1) with the lectotype of *S. rigidius* (Fig. 2), and comparing these with herbarium specimens and published descriptions of *Oxypolis ternata* and *O. rigidior,* provide further clues and convincing evidence that *S. denticulatum* is a synonym of *O. rigidior* not *O. ternata*. Differences are especially apparent in the leaf morphology (Figs. 1–3). These and other morphological differences between the species are summarized in Table 1. Information in Table 1 was compiled from a number of sources (Weakley 2008; Radford & et al. 1968; Rodgers 1950; Mathias & Constance 1945; Torrey & Gray 1840), as well as from personal examination of numerous specimens from the following herbaria: DUKE, F, ILL, ILLS, NCU, UGA, USF, and USCH.

Oxypolis ternata and *O. rigidior* can be distinguished by the following: The leaves of *O. ternata* are either unifoliate or ternate and palmately disposed. The leaflets are petiolulate, parallel-veined, always entire, and filiform to linear, typically being no more than 6 mm wide. The number of rays on the compound umbel is 5–10. In contrast, the leaves of *O. rigidior* are pinnately disposed with 5–13 sessile leaflets, reticulate-veined, remotely dentate or entire (it is rare to find a plant without some leaflets that are dentate in the upper part of the leaf), linear-lanceolate to elliptic-lanceolate, and 5–45 mm wide. The number of rays is 12–45.

No type has been located for *Peucedanum ternatum*. Inquiries or searches were made of all herbaria listed by the Harvard University Herbarium Index of Botanists to have known Nuttall collections. Nuttall gave North and South Carolina as the locality for *P. ternatum*. A specimen collected in South Carolina by A.E. Radford is herein designated as the neotype (Fig. 3).

Oxypolis ternata (Nutt.) A. Heller, Cat. N. Amer. Pl. 5. 1898. *Peucedanum ternatum* Nutt., Gen. N. Amer. Pl. 1:182. 1818. *Sataria linearis* Raf., New Fl. 4:21. 1838 (nom. illeg.). *Archemora ternata* (Nutt.) Nutt. in Torr. & A. Gray, Fl. N. Amer. 1:631. 1840. *Tiedemannia ternata* (Nutt.) J.M. Coult. & Rose, Bot. Gaz. 12:74. 1887. Type: U.S.A. South Carolina. Georgetown Co.: ditch, near US 701, 3 mi S–SW of Yauhannah, 20 Oct 1957, *A.L. Radford 31381* (neotype, designated here: NCU!; duplicates of the neotype: UC!, UF!, SMU!).

Sataria linearis Raf., var. *longipes* Raf., New Fl. 4:21. 1838. Rafinesque did not cite a specific collection or give a locality.

Neurophyllum longifolium Torr. & A. Gray, Fl. N. Amer. 1:613. 1840. Types: U.S.A. North Carolina. [Cravern Co.]: "Swamps near Newbern, North Carolina, *Mr. Croom! Dr. Loomis!* Middle Florida, *Mr. Croom!* Sept." (lectotype, designated here: NY!). Syntype: NORTH CAROLINA: New Bern, s.d., *H.B. Croom s.n.* (PH!).

Oxypolis rigidior (L.) Raf., Bull. Bot. 1:218. 1830. *Sium rigidius* L., Sp. Pl. 1:251. 1753. *Oenanthe rigidius* (L.) Crantz, Cl. Umbell. Emend. 85. 1767, '*rigida*'. *Pastinaca rigidior* (L.) Spreng. in Roemer & Schultes, Syst. Veg. 6:586. 1820, '*rigida*'. *Archemora rigidior* (L.) DC., Prodr. 4:188. 1830, '*rigida*'. *Peucedanum rigidius* A.W. Wood, Amer. Bot. Fl. 136. 1870, *nom. illeg.*, non Bunge (1833), '*rigidum*'. *Tiedemannia rigidior* (L.) J.M. Coult. & Rose, Bot. Gaz. 12:74. 1887, '*rigida*'. Type: U.S.A. Virginia: *J. Clayton 279* (lectotype, designated by J.L. Reveal in C.E. Jarvis et al., Taxon 55:215. 2006: BM, digital image!).

Archemora serrata Raf., Herb. Raf. 78. 1833. Type: U.S.A. Kentucky & Tennessee: specimen not located.

Archemora trifoliata Raf., Herb. Raf. 78. 1833. Type: U.S.A. Missouri: specimen not located.

Oenanthe ambigua Nutt., Gen. N. Amer. Pl. 1:189. 1818. *Pastinaca ambigua* (Nutt.) Torr., Fl. N. Middle United States 315. 1824. *Archemora ambigua* (Nutt.) DC., Prodr. 4:188.1830. *Archemora rigidior* (L.) DC. var. *ambigua* A. Gray, Manual 158. 1848, '*rigida*'. *Peucedanum rigidius* A.W. Wood var. *ambiguum* A.W. Wood, Amer. Bot. Fl. 136. 1870, '*rigidum*'. *Tiedemannia rigidior* (L.) J.M. Coult. & Rose var. *ambigua* (Nutt.) J.M. Coult. & Rose, Rev. N. Amer. Umbell. 47. 1888, '*rigida*'. *Oxypolis rigidior* (L.) Raf., var. *ambigua* (Nutt.) B.L. Rob., Rhodora 10:35. 1908. Type: U.S.A. Pennsylvania. Philadelphia Co.: banks of the Delaware River near Philadelphia, s.d., *T. Nuttall s.n.* (PH, digital image!).

Oxypolis turgida Small, Man. S.E. Fl. 986. 1933. Type: U.S.A. Virginia. Staunton Co.: Staunton, 2 Oct 1895, *W.A. Murrill s.n.* (lectotype, designated here: NY!).

Sium denticulatum Baldwin in S. Elliott, Sketch Bot. S. Carolina 1:354. 1817. *Archemora denticulata* (Baldwin) DC., Prodr. 4:188. 1830. *Oxypolis denticulata* (Baldwin) Raf., Bull. Bot. 1:218. 1830. *Pastinaca denticulata* (Baldwin) D. Dietr., Syn. Pl. 2:971. 1840. Type: U.S.A. Georgia: 1817, *W. Baldwin s.n.* (lectotype, designated by Edmondson 2005: LINN-Smith, digital image!).

Sium longifolium Pursh, Fl. Amer. Sept. 194. 1813. *Oxypolis rigidior* (L.) Raf., var. *longifolia* (Pursh) Britton, Mem. Torrey Bot. Club 5:239.

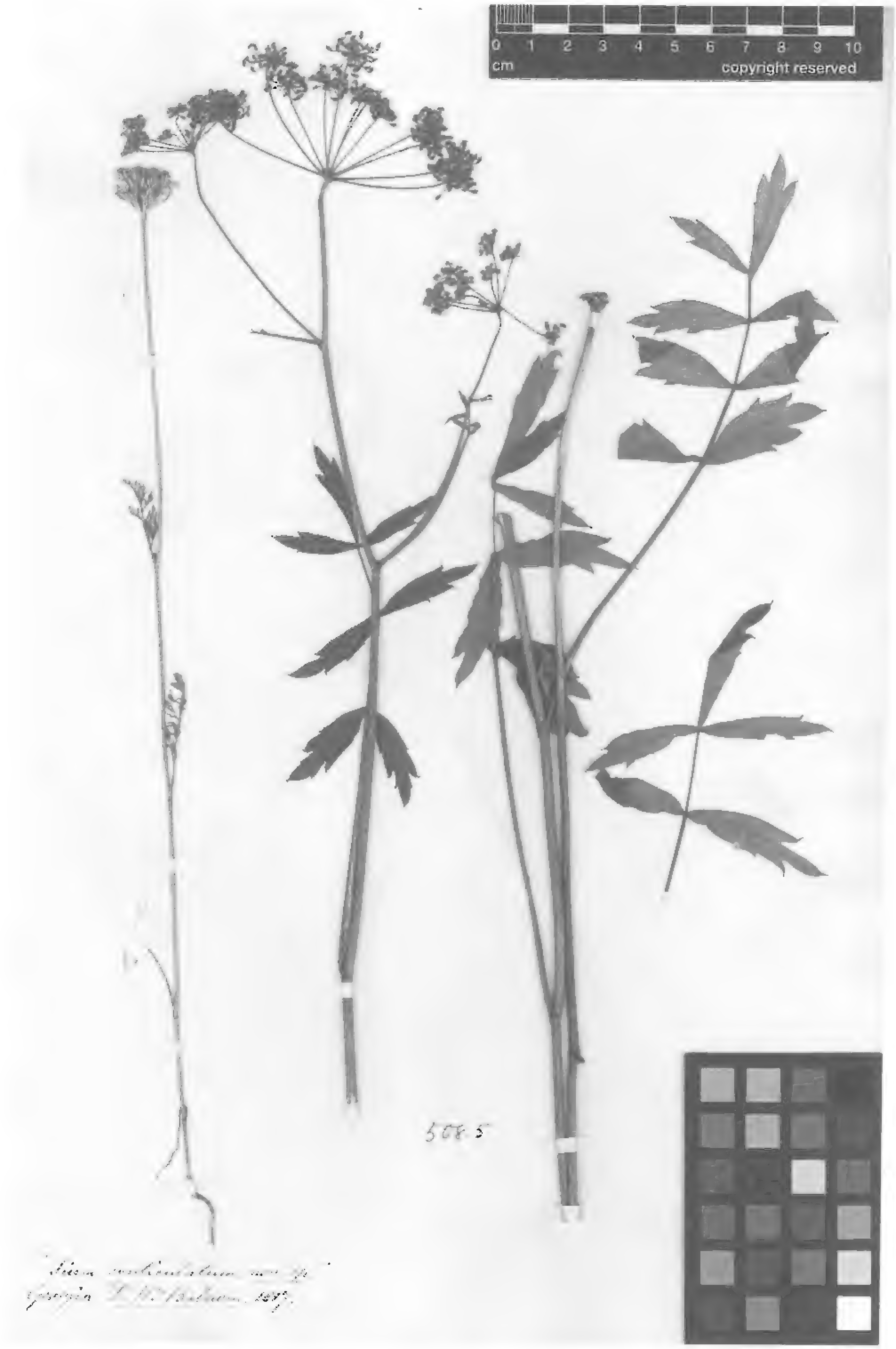

0 1 2 3 4 5 6 7 8 9 10
cm
copyright reserved
508.5

Fig. 1. *Sium denticulatum* lectotype (LINN-Smith no.: 508.5) collected by William Baldwin in 1817. Image used with kind permission of the Linnean Society of London.

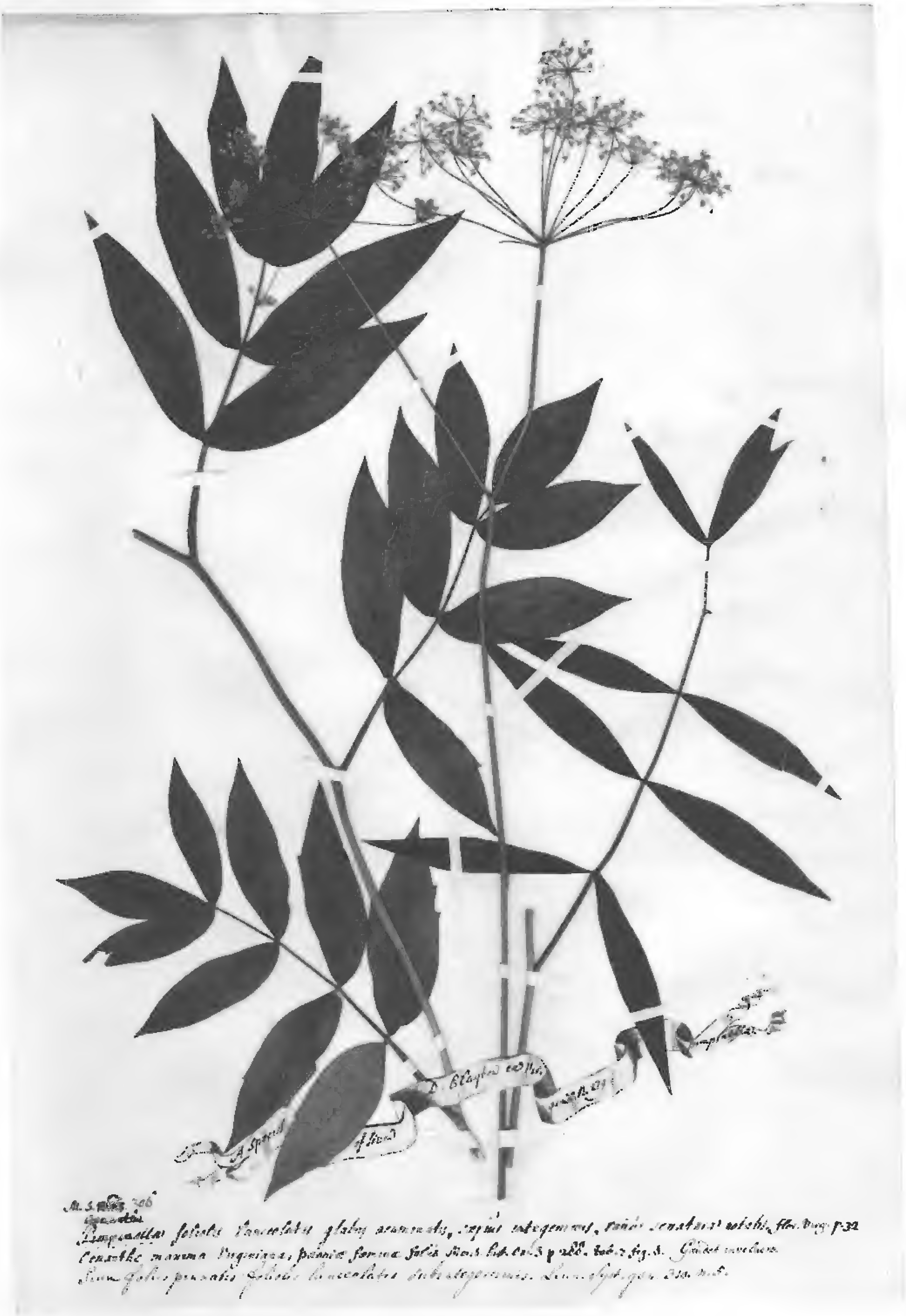


Fig. 2. *Sium rigidius/Oxypolis rigidior* lectotype (BM-000042233) collected by Clayton (no date given). Image used with kind permission of the Museum of Natural History, London.

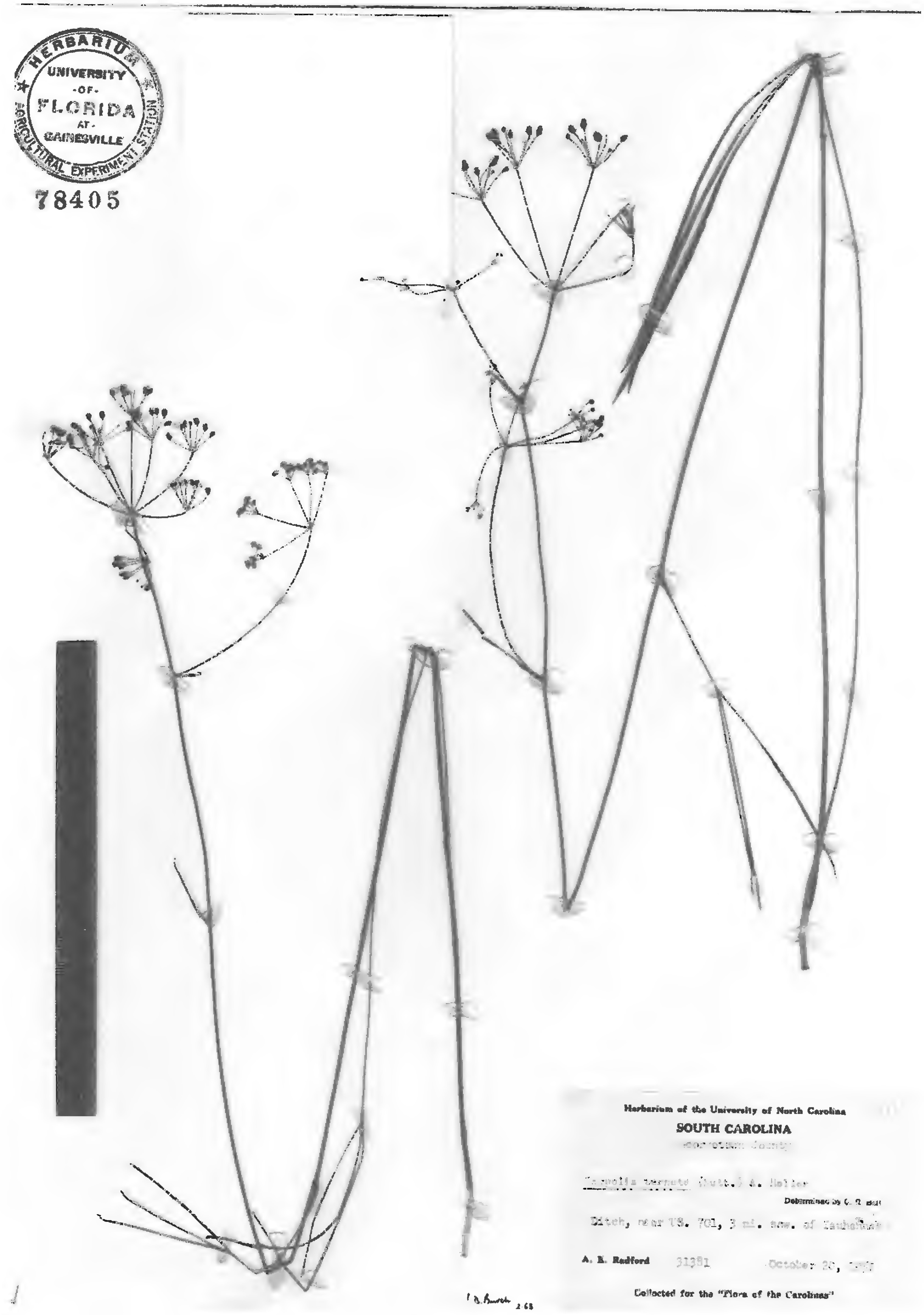

HERBARIUM
UNIVERSITY
-OF-
FLORIDA
AT-
GAINESVILLE
AGRICULTURAL EXPERIMENT STATION
78405
Herbarium of the University of North Carolina
SOUTH CAROLINA
Determined by
Ditch, near US. 701, 3 mi.
A. E. Radford
31351
October 26,
Collected for the "Flora of the Carolinas"

Fig. 3. *Oxypolis ternata* neotype (NCU-120497) collected by Radford in 1957.

TABLE 1. Morphological characters distinguishing *Oxypolis ternata* (Nutt.) A. Heller and *Oxypolis rigidior* (L.) Raf.

Characters	*Oxypolis ternata*	*Oxypolis rigidior*
Petiole length	10–30(–35) cm	5–10 cm
Leaf disposition	palmate	pinnate
Leaflet number	(1)3	(5–)7–11(–13)
Leaflet veination	parallel	reticulate
Leaflet margin	entire	(entire) remotely dentate
Leaflet shape	linear to filiform	linear-lanceolate to elliptic-lanceolate
Leaflet length	7–22	7–15 cm
Leaflet width	1–6 mm	5–45 mm
Leaflets	petiolulate	sessile
Ray number	5–10	12–45

1894, '*rigidus* var. *longifolius*'. *Oxypolis longifolia* (Pursh) Small, Fl. S.E. U.S. 875, 1336. 1903. *Oxypolis rigidior* (L.) Raf. subsp. *longifolia* (Pursh) W. Stone, Pl. S. New Jersey 2:600. 1911. TYPE: U.S.A. NEW JERSEY: (LECTOTYPE, designated with reservations by Ewan 1979: PH, digital image!).

Sium tricuspidatum Elliott, Sketch Bot. S. Carolina 1:354. 1817. *Archemora tricuspidata* (Elliott) DC., Prodr. 4:188. 1830. *Oxypolis tricuspidata* (Elliott) Raf., Bull. Bot. 1:218. 1830. *Pastinaca tricuspidata* (Elliott) D. Dietr., Syn. Pl. 2:971. 1840. TYPE: U.S.A. SOUTH CAROLINA: (HOLOTYPE: CHARL!).

ACKNOWLEDGMENTS

I would like to thank Emilie Bess, J. Leland Crane, Stephen R. Downie, Geoffrey A. Levin, Anthony R. Magee, Brenda Molano-Flores, and James R. Reveal for helpful discussions or comments relating to this manuscript.

REFERENCES

EDMONDSON, J.R. 2005. A new combination in *Oxypolis* Raf. (Apiaceae). Novon 15:109.

ELLIOTT, S. 1817. A sketch of the botany of South Carolina and Georgia. 2 vols. J.R. Schenck, Charleston, South Carolina.

EWAN, J. 1979. Introduction to the facsimile reprint of Frederick Pursh, Flora Americae Septentrionalis (1814). In: F.T. Pursh, Flora Americae Septentrionalis. Facsimile reprint. J. Cramer, Braunschweig, Germany.

MATHIAS M. AND L. CONSTANCE. 1945. Umbelliferae. N. Amer. Fl. 28B:43–295.

MCNEILL J., F.R. BARRIE, H.M. BURDET, V. DEMOULIN, D.L. HAWKSWORTH, K. MARHOLD, D.H. NICOLSON, J. PRADO, P.C. SILVA, J.E. SKOG, J.H. WIERSEMA, AND N.J. TURLAND. 2006. International code of botanical nomenclature (Vienna Code). Regnum Veg. 146.

NUTTALL, T. 1818. The genera of North American plants, and a catalogue of species to the year 1817. 2 vols. D. Heartt, Philadelphia, Pennsylvania.

RADFORD, A.E., H.E. AHLES, AND C.R. BELL. 1968. Manual of the vascular flora of the Carolinas. University of North Carolina Press, Chapel Hill, North Carolina.

RAFINESQUE, C.S. 1825. Neogenyton, or indication of sixty-six new genera of plants of North America. Published by the author, Lexington, Kentucky.

RAFINESQUE, C.S. 1830. Extract d'une lettre de M.S.C. Rafinesque, professeur à Philadelphie, addressée à M. le professeur De Candolle. (Mai 1830). Bull. Bot. 1:214–221.

RODGERS C.L. 1950. The Umbelliferae of North Carolina and their distribution in the southeast. J. Elisha Mitchell Sci. Soc. 66:195–266.

TORREY, J. AND A. GRAY. 1840. A flora of North America. Wiley & Putnam, New York.

WEAKLEY, A.S. 2008. Flora of the Carolinas, Virginia, and Georgia, and surrounding areas. University of North Carolina Herbarium, North Carolina Botanical Garden, University of North Carolina at Chapel Hill.

NEOTYPIFICATION OF *ARTEMISIA CARRUTHII* (ASTERACEAE: ANTHEMIDEAE)

Caleb A. Morse
R.L. McGregor Herbarium
Division of Botany, Natural History Museum
and Biodiversity Research Center
University of Kansas
2045 Constant Ave
Lawrence, Kansas 66047-3729, U.S.A.
cmorse@ku.edu

James L. Reveal
L.H. Bailey Hortorium Herbarium
Department of Plant Biology
Cornell University
412 Mann Library Bldg
Ithaca, New York 14853-4301, U.S.A.
jlr326@cornell.edu

ABSTRACT

Authentic material of *Artemisia carruthii* Alph. Wood ex Carruth was lost after publication of the name. Accordingly a neotype is selected and typification of names now considered synonymous of that species, *A. wrightii* A. Gray, *A. kansana* Britton, *A. coloradensis* Osterh., *A. bakeri* Greene, and *A. pringlei* Greenm. is reviewed with "step 2" lectotypes designated for *A. coloradensis* and *A. bakeri* and a "step 3" lectotype designated for *A. wrightii*.

RESUMEN

El material original de *Artemisia carruthii* Alph. Wood ex Carruth se perdió después de la publicación del nombre. Por ello se selecciona un neotipo y se tipifican los nombres que ahora se consideran sinónimos de esa especie, *A. wrightii* A. Gray, *A. kansana* Britton, *A. coloradensis* Osterh., *A. bakeri* Greene, y *A. pringlei* Greenm. Se revisan con "paso 2" lectotipos designados para *A. coloradensis* y *A. bakeri* y un "paso 3" se designa lectotipo para *A. wrightii*.

James Harrison Carruth (1807–1896) published three new species attributed to Alphonso Wood in his "Centennial catalog of the plants of Kansas" (1877). The disposition of one of these, *Cyperus spiculatus* Alph. Wood ex Carruth (Cyperaceae), likely a later synonym of *C. erythrorhizos* Muhl., has been discussed by McGregor and Brooks (1982). It is not clear that Carruth actually intended to publish the second species, *Muhlenbergia innominata* Alph. Wood in Carruth (Poaceae) as new to science, rather than merely indicating that Wood had identified it as undescribed. Although it meets the requirements for publication, the description was reproduced almost verbatim from Carruth (1873), where the taxon was first described without an epithet. The status of this name was not addressed by McGregor and Brooks (1982), and the name has been overlooked by other authors. Original material has not been located. The third species, *Artemisia carruthii* Alph. Wood ex Carruth, was published with this statement as its protolog:

> 481. †A. Carruthii sic vult Mr. Wood, nov. sp. Erect, simple, clothed all over in a white tomentum. Leaves pinnately parted, with linear segments, the lower bipinnately, with leafy, axillary tufts, all close-pressed, 1' [inch] and less long. Heads oblong, small, 1" [line], 7-lined flowered, homogamous, all condensed in a narrow, spike-like panicle. Plant 1–2 feet.

Carruth did not cite type material or place of collection, and the species is not figured in the publication. Here, we discuss the source and fate of the original material, which appears to have been lost around the time of publication. To fix application of the name, we designate a neotype.

In an 1892 letter to Bernard B. Smyth (1843–1913), Carruth suggests that original material was in existence at the time he published these names, reporting that he had sent "several specimens to [Wood]", and that names published in his 1877 list were based on those specimens (Carruth 1892). That Carruth took pains to indicate that the description of *Artemisia carruthii* was his own and not merely transcribed from correspondences from Wood, as he did in the case of *Muhlenbergia innominata*, suggests that a least one set of specimens was in his possession at or near the time of publication. However, original material was almost certainly not collected by Carruth himself. Carruth (1877) noted that the he had "not traveled widely, but [was] greatly aided by the observations of others." Carruth was stationed in Lawrence, Kansas, at the time

J. Bot. Res. Inst. Texas 3(2): 667 – 672. 2009

of the publication of his Centennial Catalogue, and it does not appear that he made any excursions to the western half of the state prior to 1881 (Carruth 1879, 1881), when he reported having travelled as far west as Barton County (Carruth 1881–1882). As a consequence, many of the taxa included in his floristic lists of 1872, 1873, 1874, and 1877 were based on submissions contributed by a "corps of observers" (Carruth 1873). Carruth incorporated into his lists reports of species provided by these observers, but he also received hundreds of specimens for determination, and it is likely that the first specimen of *A. carruthii* was taken by one of several collectors who lived in or traveled through western Kansas in the 1870s.

Carruth frequently failed to cite collectors of voucher specimens by name, but did include a station for most specimens, from which it is often possible to deduce the donor. Unfortunately, the usual citation of a place of collection is omitted for *Artemisia carruthii*. Of the individuals who had collected in the western part of the state prior to its publication, Carruth reported receiving specimens from areas within the range of *A. carruthii* from three individuals: the paleontologist Benjamin Franklin Mudge (1817–1879) is credited with contributing five specimens from "S. W. Kansas" and "W. Kansas" (Carruth 1872, 1877); Louis Watson (1817–1894), a medical doctor and cousin of Sereno Watson (1826–1892), is presumed to have taken most if not all of the specimens Carruth recorded from Ellis, Ellis County (Carruth 1873, 1874, 1877) and contributed "400 to 500 species, often many of each" (Carruth 1877); and Francis Huntington Snow (1840–1908), Professor of Natural History (and eventually Chancellor) at the University of Kansas, and his students were credited with specimens and observations from Russell County among other stations (Carruth 1874, 1877). A single specimen from Ellis attributed to a collector cited as "L'Her" (Carruth 1877) is presumed here to be a typographical error. Interestingly, Edwin Alonzo Popenoe (1853–1913), professor at Kansas State Agricultural College, who traveled throughout the western part of the state and on whose authority Carruth (1877) credits stations in fourteen counties, seems to have contributed only reports of species, but no specimens (Carruth 1873, 1874, 1877).

Carruth's own herbarium was reputed to be poorly maintained and disposed of when he departed Lawrence in 1892 (McGregor & Brooks 1982), and any material in existence is likely to have been discarded at that time. However, it is possible that he had deposited some specimens in one of several botanical institutions in the state. In addition to serving as state botanist, Carruth held appointments as Professor of Natural History at Baker University in Baldwin City and as a lecturer at Washburn University in Topeka (McGregor & Brooks 1982), and he may have deposited some vouchers in the botanical collections of either institution. In addition, a small number of specimens collected by Carruth, Snow, and Watson remains at KANU, and a few collected by Snow and Watson remain at KSC; several specimens gathered by Watson are also at GH. Alphonso Wood's herbarium and types were deposited at NY sometime after his death in 1879 (Stafleu 1967), although material from his herbarium has been identified in other institutions.

Whatever the fate of Carruth's holdings of *Artemisia carruthii*, it appears that the material was lost to students of the Kansas flora soon after publication. The name seems to have fallen into obscurity almost immediately after Carruth's departure from Kansas. It was overlooked by authors of subsequent compilations of, and novelties to, the flora of the state. *Artemisia carruthii* was not included in the treatments of Kellerman and Kellerman (1888), Smyth (1889, 1892b), or Hitchcock (1899), or listed among the 145 species excluded by Smyth (1890). Smyth (1892a, 1892b) cited *A. wrightii* A. Gray for several Kansas counties and later (1898) suggested that *A. kansana* Britton "may be a form of *A. frigida*," which he had previously cited (Smyth 1890, 1892a, 1892b) for stations outside the range of that species in Kansas. Indeed, no early specimens deposited in KANU, KSC, or WASH were determined by the collectors to be *A. carruthii*, these being variously named *A. filifolia* Torr., *A. frigida* Willd., *A. kansana*, or *A. wrightii* as late as 1931. That Smyth, who corresponded rather extensively with Carruth, did not even discuss *A. carruthii* suggests that he had not seen original material in Kansas herbaria, particularly KSC and WASH, which he was likely to have examined during the preparation of his floristic lists.

Artemisia carruthii was first resurrected for the Missouri flora by Mackenzie (1902), who listed *A. kansana* as a synonym without comment. In the ensuing debate about the correct name for this taxon, no type material was cited—most likely because it was not seen—by Rydberg (1910), Britton and Brown (1913), Hall and Clements (1923), Bush (1928), Gates (1939), or Keck (1946). Notable among these authors were Britton and Brown, whose listing of *A. carruthii* as only a questionable synonym of *A. kansana* suggests that Britton had not seen material at NY referable to *A. carruthii* at the time of publication. Hall and Clements discuss *A. carruthii* at length, but—unusual for these authors—also do not cite a type specimen. Acknowledging that *A. carruthii* was the earliest available name for the element they recognized as a subspecies of *A. vulgaris* L., Hall and Clements (1923) nevertheless chose to employ Asa Gray's epithet in publishing the combination *A. vulgaris* var. *wrightii*, citing the earlier name as "not well established" (p 81), commenting (p. 82) that Gray "did not intend to establish a species distinct from *A. carruthii*, the earlier publication of which he apparently overlooked." Results of biosystematic studies by Ray (1971) and Bol (1984) supported Keck's (1946) circumscription of *A. carruthii*, and most authors of recent floras and checklists have accepted the name (*e.g.* Martin & Hutchins 1981, Barkley 1991, Cronquist 1994, Jones et al. 1997, Welsh 2003, Kaul et al. 2006, Voss 1996, Yatskievych 2006, Shultz 2006). However, none of these authors have resolved typification of the species. It was not accepted by Ling (1995), who treated *A. wrightii* as having priority, apparently based on an error transcribing the publication date of the latter name.

Artemisia carruthii is broadly distributed from the southwest Great Plains though the eastern part of the Great Basin, New Mexico, Arizona, and northern Mexico (Shultz 2006), and it is reported to be adventive in Michigan (Voss 1996) and Missouri (Yatskievych 2006). Welsh (2003) and Shultz (2006) reported that *A. carruthii* intergrades with *A. ludoviciana* Nutt., so it is important to fix application of the name by selecting a type. The senior author attempted in October 2007 and January 2008 to locate original material of *A. carruthii* for designation as a lectotype. Requests to identify specimens collected in Kansas in or before 1880 were sent to staff at Baker University, FHKSC, ISC, KSTC, GH, NY, PH, and YU. Holdings at KANU, KSC, and WASH were examined by the senior author; holdings at MO were examined on the authors' behalf by Craig Freeman (Curator, KANU). These searches proved unsuccessful, and it seems doubtful that original material remains. Consequently, a neotype is designated below in accordance with Art. 9.15 of ICBN (McNeil et al. 2006). Following the taxonomic circumscription first proposed by Keck (1946) and accepted by subsequent authors, we also discuss the typification of names considered synonymous of *A. carruthii*, designating "step 2" lectotypes for *A. coloradensis* Osterh. and *A. bakeri* Greene, and a "step 3" lectotype for *A. wrightii* (discussed by McNeil et al. [2006] in Art. 9, Ex. 8, and by Anderson [2007]).

Artemisia carruthii Alph. Wood ex Carruth, Trans. Kansas Acad. Sci. 5:51. 1877. *Artemisia vulgaris* L. var. *carruthii* (Alph. Wood ex Carruth) F.C. Gates, Trans. Kansas Acad. Sci. 42:138. 1939. Type: UNITED STATES. Kansas. Hamilton Co.: 3.25 mi N, 3.5 mi W Syracuse, S side of Hamilton County State Fishing Lake & Wildlife Area, T23S R41W sec 28 SE¼ of NE¼, 38.02517°N, 101.81783°W, elev. 3340 ft, disturbed shortgrass prairie on eroded, W-facing slopes along Plum Creek below dam, 9 Oct 2007, *C.A. Morse 16097* (NEOTYPE: KANU sheet 361746, designated here; DUPLICATES OF THE NEOTYPE: BH, BRIT, BRY, COLO, CS, FHKSC, ISC, K, KANU, KSC, KSTC, GH, MEXU, MICH, MO, ND, NEB, NY, OKL, OKLA, PH, RM, TEX, WASH, WIS, US, UTC, YU).

Artemisia wrightii A. Gray, Proc. Amer. Acad. Arts 19:48. 1883. *Artemisia vulgaris* L. subsp. *wrightii* (A. Gray) H.M. Hall & Clem., Publ. Carnegie Inst. Washington 326:80, pl 9. 1923. *Artemisia vulgaris* var. *wrightii* (A. Gray) E.J. Palmer & Steyerm., Ann. Missouri Bot. Gard. 22:677. 1935. *Artemisia carruthii* var. *wrightii* (A. Gray) S.F. Blake, J. Washington Acad. Sci. 30:472. 1940. Type: UNITED STATES. New Mexico. Grant Co.: Santa Rita del Cobre, 1851, *C. Wright 1279* (LECTOTYPE: a first step lectotypification designated by Standley [1910: 218] as "type," here corrected; NY, a second step lectotypification designated by Hall and Clements [1923: 81] as "type," here corrected; NY sheet 158580, a third step lectotypification, designated here; DUPLICATES OF THE LECTOTYPE: GH [three sheets annotated by Asa Gray as *A. wrightii*], NY, US).

Artemisia kansana Britton, N.L. Britton & A. Brown, Ill. Fl. N. U.S. 3:466. 1898. Type: UNITED STATES. KANSAS. Lane Co.: plains, 15 Aug 1895, *A.S. Hitchcock 302* (HOLOTYPE: NY; ISOTYPES: GH, KSC, RM, US).

Artemisia coloradensis Osterh, Bull. Torrey Bot. Club 27:506. 1900. *Artemisia wrightii* var. *coloradensis* (Osterh.) A. Nelson, New Man. Bot. Centr. Rocky Mts. 568. 1909. Type: UNITED STATES. Colorado. Larimer Co.: Dale Creek, 7 Sep 1899, *G.E. Osterhout 2010* (LECTOTYPE: RM, a first step lectotypification designated by Keck [1946: 440] as "type," here corrected; RM sheet 170628, a second step lectotypification designated here; DUPLICATES OF THE LECTOTYPE: NY, POM, RM [2 sheets]).

Artemisia bakeri Greene, Pl. Baker 3:31. 1901. *Artemisia mexicana* Willd. ex Spreng. var. *bakeri* (Greene) A. Nelson in New Man. Bot. Centr. Rocky Mts. 569. 1909. Type: UNITED STATES. Colorado. Montrose Co.: canyon of the Gunnison River near Cimarron, Aug 1896, *E.L. Greene s.n.* (LECTOTYPE, a first step lectotypification designated by Hall and Clements [1923: 81] as "type," here corrected;

ND-G sheet 062066, a second step lectotypification designated here; DUPLICATE OF THE LECTOTYPE: ND-G).

Artemisia pringlei Greenm., Proc. Amer. Acad. 40:50. 1904. TYPE: MÉXICO. CHIHUAHUA: plains near Chihuahua, 11 Sep 1885, *C.L. Pringle 625* (LECTOTYPE: GH designated by Hall and Clements [1923: 81] as "type," here corrected; DUPLICATES OF THE LECTOTYPE: DS, NY [2 sheets], PH, US).

Notes

Standley (1910) merely restricted application of *Artemisia wrightii* to the Wright collection, whereas Hall and Clements (1923) designated one of two specimens at NY as the "type." A more logical choice would have been one of the three sheets annotated by Gray at GH. We hereby restrict the choice to a single sheet at NY.

Keck annotated a duplicate of *Osterhout 2010* (171095) as the "type" perhaps because the original Osterhout specimen (170628), marked with a small, red, preprinted label with the word "Type" was not seen by Keck in 1939. Because there were three sheets of *Osterhout 2010* at RM prior to 1946, however, we consider Keck's actions a first step lectotypification as he did not distinguish between the three sheets. It should be noted that Hall and Clements (1923) did not cite collection information of *Artemisia coloradensis*, other than to remark (p. 82) "Type locality, near Dale Creek, Larimer County, Colorado." This by itself does not qualify as an effective lectotypification.

Hall and Clements (1923: 81) stated that the type of *Artemisia bakeri* "was collected by Greene in the canyon of the Gunnison, near Cimmaron, Colorado. This has not been seen [by us], but the above notes are based upon other specimens cited by Greene, namely, Black Canon, Gunnison Watershed, Colorado, *Baker 698* (Gr, UC, US)." As they did not indicate where the Greene specimen was to be sought, our second step lectotypification completes their designation of the lectotype.

ACKNOWLEDGMENTS

We thank James Estes, Craig Freeman, and Leila M. Shultz for reviewing the manuscript and providing helpful comments. Carolyn Beans (GH), Roger Boyd (Baker University), Tom Eddy (KSTC), Alina Freire-Fierro (PH), Barbara Hellenthal (ND), Jill Larson (RM), Deborah Lewis (ISC), Mark Mayfield (KSC), Melissa Rossow (NY), Patrick Sweeney (YU), Joe Thomasson (FHKSC), and Mark Allen Wetter (WIS) supplied data on the holdings at their respective institutions. Craig Freeman (KANU) examined holdings at MO. In addition, John Boggan (US), Carolyn Beans, Mark Mayfield, and Melissa Rossow kindly provided images of type specimens not already available through their institution's website. Lisa DeCesare (Botany Librairies, Harvard University) and Marie Long (Mertz Library, New York Botanical Garden) searched their holdings for correspondence between Carruth and Wood. Ronald Hartman (RM) provided insights into the annotation history of Osterhout's types. Vic Landrum provided both information about and access to the collection at WASH. Curators of KSC, ND, RM, and WASH kindly provided specimen loans. The senior author's fieldwork was made possible through an anonymous contribution to the McGregor Herbarium endowment.

REFERENCES

ANDERSON, W.R. 2007. Lectotypification of names of Malphigiaceae—I. Contr. Univ. Michigan Herb. 25:83–93.

BARKLEY, T.M. 1991. Asteraceae. In Great Plains Flora Association. Flora of the Great Plains. University Press of Kansas, Lawrence. Pp. 838–1020.

BOL, E. L. 1984. Biosystematics of *Artemisia carruthii* and *Artemisia mexicana*. Unpublished master's thesis, Univeristy of Oklahoma, Norman.

BRITTON, N.L. AND A. BROWN 1913. An illustrated flora of the northern United States, Canada, and the British Possessions. Volume 3: Gentianaceae to Compositae. Second edition. Charles Scribner's Sons, New York.

BUSH, B.F. 1928. The Missouri artemisias. Amer. Midl. Naturalist 11:25–40.

CARRUTH, J.H. 1872. Catalog of plants seen in Kansas. Trans. Kansas Acad. Sci. 1:8–20.

CARRUTH, J.H. 1873. Report on the botany of Kansas for the year 1873. Trans. Kansas Acad. Sci. 2:74–79.

CARRUTH, J.H. 1874. Report on botany, 1874. Trans. Kansas Acad. Sci. 3:122–127.

CARRUTH, J.H. 1877. Centennial catalogue of the plants of Kansas. Trans. Kansas Acad. Sci. 5:40–59.

Carruth, J.H. 1879. Letter to B. B. Smyth, 13 May 1879. James Harrison Carruth Collection, Kansas Collection, RH MS P41, Kenneth Spencer Research Library, University of Kansas, Lawrence.

Carruth, J.H. 1881. Letter to B. B. Smyth, 18 Oct 1881. James Harrison Carruth Collection, Kansas Collection, RH MS P41, Kenneth Spencer Research Library, University of Kansas, Lawrence.

Carruth, J.H. 1881–1882. Botanical addenda for 1881 and 1882. Trans. Kansas Acad. Sci. 8:32–33.

Carruth, J. H. 1892. Letter to B. B. Smyth, 7 Sep 1892. James Harrison Carruth Collection, Kansas Collection, RH MS P41, Kenneth Spencer Research Library, University of Kansas, Lawrence.

Cronquist, A. 1994. *Artemisia*. In A. Cronquist, A.H. Holmgren, N.H. Holmgren, J.L. Reveal and P.K. Holgren, Intermountain flora, vol. 5: Asterales. New York Botanical Garden, Bronx. Pp. 146–164.

Gates, F.C. 1939. New forms and nomenclatorial combinations in the Kansas flora. Trans. Kansas Acad. Sci. 42:135–138.

Hall, H.M. and F.E. Clements. 1923. The phylogenetic method in taxonomy: the North American species of *Artemisia*, *Chrysothamnus*, and *Atriplex*. Carnegie Inst. Washington Publ. 326:i–iv, 1–355.

Hitchcock, A.S. 1899. Flora of Kansas. Kansas State Agricultural College, Manhattan.

Jones, S.D., J.K. Wipff, and P.M. Montgomery. 1997. Vascular plants of Texas: a comprehensive checklist including synonymy, bibliography, and index. University of Texas Press, Austin.

Kaul, R.B., D.M. Sutherland, and S.B. Rolfsmeier. 2006. The flora of Nebraska. School of Natural Resources, University of Nebraska – Lincoln, Lincoln.

Keck, D.D. 1946. A revision of the *Artemisia vulgaris* complex in North America. Proc. Calif. Acad. Sci., ser. 4, 25:421–468.

Kellerman, W.A. and S.V. Kellerman. 1888. Analytical flora of Kansas. Published by the authors, Manhattan, Kansas.

Ling, Y.-R. 1995. 13. The New World *Artemisia*. In D.J.N. Hind, C. Jeffrey, and G.V. Pope, eds. Advances in Compositeae systematics. Royal Botanic Gardens, Kew. Pp. 255–281.

Mackenzie, K.K. 1902. Manual of the flora of Jackson County, Missouri. Published by the author, Kansas City, Missouri.

Martin, W.C. and C.R. Hutchins. 1981. A flora of New Mexico. 2 vols. J. Cramer, Vaduz.

McGregor, R.L. and R.E. Brooks. 1982. James H. Carruth and disposition of his new names based on Kansas plants. Contr. Univ. Kansas Herb. 1:1–6.

McNeill, J., F.R. Barrie, H.M. Burdet, V. Demoulin, D.L. Hawksworth, K. Marhold, D.H. Nicolson, J. Prado, P.C. Silva, J.E. Skog, J.H. Wiersema and N.J. Turland (eds.). 2006. International code of botanical nomenclature (Vienna Code) adopted by the Seventeenth International Botanical Congress Vienna, Austria, July 2005. Regnum Veg. 146.

Ray, H. E. 1971. A biosystematic study of *Artemisia carruthii*. Unpublished doctoral disseration, University of Oklahoma, Norman.

Rydberg, P.A. 1910. Studies on the Rocky Mountain flora XXIII. Bull. Torrey Bot. Club 37:443–471.

Shultz, L.M. 2006. 119. *Artemisia*. In Flora of North America Editorial Committee, eds. Flora of North America north of Mexico. Volume 19: Magnoliophyta: Asteridae (in part): Asteraceae, part 1. Oxford University Press, New York. Pp. 503–534.

Smyth, B.B. 1889. Catalogue of the flowering plants and ferns of Kansas. Bull. Washburn Coll. Lab. Nat. Hist. 2:43–61.

Smyth, B.B. 1890. Additions to the flora of Kansas. Trans. Kansas Acad. Sci. 12:105–119.

Smyth, B.B. 1892a. Check list of the plants of Kansas. Published by the author, Topeka, Kansas.

Smyth, B.B. 1892b. Additions to the flora of Kansas. Trans. Kansas Acad. Sci. 13:96–103.

Smyth, B.B. 1898. Additions to the flora of Kansas. Trans. Kansas Acad. Sci. 13:158–167.

Stafleu, F.A. 1967. Taxonomic Literature: a selective guide to botanical publications with dates, commentaries and types. International Bureau for Plant Taxaonomy and Nomenclature. Utrecht, Netherlands. Regnum Veg. 52.

Standley, P.C. 1910. The type localities of plants first described from New Mexico. Contr. U.S. Natl. Herb. 13:143–246, xiv.

Voss, E.G. 1996. Michigan flora. Part III: Dicots (Pyrolaceae – Compositae). Cranbrook Institute of Science Bulletin

61, Bloomfield Hills, and University of Michigan Herbarium, Ann Arbor.

Welsh, S.L. 2003. Compositae Giseke, Sunflower family. In Welsh, S.L., N.D. Atwood, S. Goodrich, and L.C. Higgins. A Utah flora. Third edition. Monte L. Bean Life Science Museum, Brigham Young University, Provo, Utah. Pp. 122–245.

Yatskievych, G. 2006. Steyermark's flora of Missouri. Vol. 2. Missouri Botanical Garden, St. Louis.

A PHYLOGENY OF *ARCTOSTAPHYLOS* (ERICACEAE) INFERRED FROM NUCLEAR RIBOSOMAL ITS SEQUENCES

Gregory A. Wahlert
Department of Environmental and Plant Biology
Ohio University
Athens, Ohio 45701, U.S.A.
gw807105@ohio.edu

V. Thomas Parker
Department of Biology
San Francisco State University
San Francisco, California 94132, U.S.A.
parker@sfsu.edu

Michael C. Vasey
Department of Environmental Studies
University of California, Santa Cruz
Santa Cruz, California 95064, U.S.A.
mvasey@ucsc.edu

ABSTRACT

A phylogeny of *Arctostaphylos* (Ericaceae) was estimated using nuclear ribosomal ITS sequence data for 98 species, of which 83 were unique taxa and 15 were multiple samples of geographically widespread or morphologically variable species (*A. uva-ursi*, *A. patula*, *A. pungens*, *A. manzanita*, *A. glandulosa*, and *A. tomentosa*). Forty-four ingroup taxa shared an identical sequence. The remaining species showed pairwise substitution rates of 2.4% or less, and 17 taxa had sequences with polymorphic positions. Maximum parsimony analysis recovered a large polytomy and three small clades. Analysis of a reduced data set with the 17 polymorphic taxa removed recovered a two-clade topology with some additional resolution within each clade. Four taxa showed patterns of sequence nucleotide additivity suggesting interspecific hybrid origin. A proposed hypothesis of higher rates of nucleotide substitution in species that are obligate seeders vs. those that are facultative sprouters could not be tested due to shared sequences. Low interspecific sequence variability in the nuclear ribosomal ITS region in *Arctostaphylos* may be due to several factors, including recent diversification of the genus in California, long generation time between sexual reproduction events, and rapid concerted evolution of nuclear ribosomal ITS arrays in both diploids and tetraploids.

Key Words: *Arctostaphylos*, generation time, interspecific hybridization, molecular phylogeny, nuclear ribosomal ITS, polyploidy, superimposed nucleotide additivity patterns.

RESUMEN

Una filogenia de *Arctostaphylos* (Ericaceae) se estableció utilizando secuencias del ADN nuclear ribosómico ITS de 98 especies de las cuales seis son de distribución geográfica amplia o morfológicamente variables están representadas por más de una accesión (*A. uva-ursi*, *A. patula*, *A. pungens*, *A. manzanita*, *A. glandulosa*, and *A. tomentosa*). Cuarenta y cuatro taxones comparten una secuencia idéntica. Las otras especies muestran una tasa de sustitución nucleotídica de 2.4% o menos, y en 17 taxones bases polimórficas. El análisis de máxima parsimonia conduce a una gran politomía, sin embargo eliminando los 17 taxones polimórficos, la topología del árbol nuevamente obtenido evidencia dos clados y algunos subclados. Cuatro taxones muestran patrones de secuencia de aditividad nucleotídica sugiriendo un origen híbrido interespecífico. La similitud de las secuencias de las especies que se reproducen estrictamente por semillas vs las que se reproducen por rebrotes y a la vez por semillas no permite confirmar la hipótesis de mayor tasa de sustitución nucleotídica en las primeras. La baja variabilidad interespecífica que muestra el ITS en *Arctostaphylos* puede deberse a varios factores, como la reciente diversificación del género en California, el largo tiempo de generación entre los eventos de reproducción sexual, y la evolución concertada rápida del ITS en las poblaciones que han experimentado eventos de hibridación en ambos niveles diploides y tetraploides.

INTRODUCTION

Arctostaphylos Adans. (Ericaceae) is composed of ca. 108 taxa and is the most species-rich genus of subfamily Arbutoideae Nied. (Wells 2000). Except for *Arctostaphylos uva-ursi* (L.) Spreng.—which has a circumboreal distribution—the remaining species are confined to western North America and Mexico. In California, species of *Arctostaphylos* occur in a variety of plant communities, including chaparral, montane scrub, mixed-coniferous forests, serpentine barrens, and oak savannas. At low latitudes, *Arctostaphylos uva-ursi* occurs in montane regions (e.g., Rockies, Appalachians, Alps, Himalayas) and in coastal pine barrens and

J. Bot. Res. Inst. Texas 3(2): 673 – 682. 2009

dunes (e.g., New Jersey and Michigan, USA). *A. uva-ursi* subsp. *cratericola* (Donn.Sm.) P.V.Wells represents a disjunct population in the volcanic highlands of Guatemala.

Arctostaphylos is placed in subfamily Arbutoideae with five other genera: *Arctous* Nied., *Arbutus* L., *Comarostaphylis* Zucc., *Ornithostaphylos* Small, and *Xylococcus* Nutt. (Diggs & Breckon 1981). Molecular and morphological phylogenetic studies in the Ericaceae place the Arbutoideae between the basalmost Monotropoideae and the rest of the family (Kron et al. 2002). Markos et al. (1998) presented phylogenetic trees for 16 species of *Arctostaphylos* inferred from nuclear ribosomal internally transcribed spacer (nrITS) and 28S nuclear ribosomal sequences. The two-clade topology recovered in their trees was not congruent with the two subgenera of Wells (2000) nor did it support the monophyly of the *A. hookeri* G.Don species complex in section *Pungens* (Markos et al. 1998). Boykin et al. (2005) presented a nrITS phylogeny of 38 taxa that also recovered a two-clade topology. Further, these two-clade phylogenies are congruent (with respect to species composition) with a phenogram constructed from flavonoid data for 20 species of *Arctostaphylos* (Denford 1981).

The center of diversity for *Arctostaphylos* is centered about San Francisco, CA in the California Floristic Province. The coastal areas and Coast Ranges of California, from Mendocino County to Santa Barbara County, are particularly rich in taxa (Markos et al. 1998). *Arctostaphylos* has a high percentage of endemic taxa, many of which are edaphic specialists (Wells 2000). Nearly half of all California taxa are considered rare, threatened, or endangered (CNPS 2009). The diversity of modern taxa may be the result of a radiation of *Arctostaphylos* since the end of the Miocene (5.3 Ma) (Edwards 2004). Factors contributing to the diversification of the genus include local adaptation to California's diverse substrates, an increase in fire frequency at the end of the Pliocene, the onset of a Mediterranean climate, and the contemporaneous expansion of chaparral into forested areas (Raven & Axelrod 1978; Axelrod 1989; Edwards 2004).

Hybridization and polyploidization are two processes driving speciation in *Arctostaphylos*. The base chromosome number in *Arctostaphylos* is $x = 13$, with most species being either diploid ($2n = 26$) or tetraploid ($2n = 52$). Schierenbeck et al. (1992) provide morphological and cytological evidence for the allopolyploid origin of *A. mewukka* Merriam. Many other taxa have been proposed as arising via homoploid hybrid speciation (e.g., Dobzhansky 1953; Gottlieb 1968; Schmid et al. 1968; Kruckeberg 1977; Knight 1985; Keeley & Massihi 1994; Parker & Vasey 2004). For a group of 46 edaphic specialists or endemic taxa, Wells (2000) proposed a hybrid origin for 37. Differing ploidy levels observed in *Arctostaphylos uva-ursi* subsp. *coactilis* Fernald & J.F.Macbr. ($2n$ = 26, 39, 52 and 78) suggests recent and recurring polyploidization, which is common in arctic plants (Rosatti 1981; Brochmann et al. 2004).

Morphological intermediacy is not always a reliable indicator of hybrid origin (e.g., Rieseberg 1995)—particularly in *Arctostaphylos*. It is likely that introgression and polyploidization in *Arctostaphylos* has lead to misleading phylogenetic inferences and taxonomic classifications that are based on morphological characters. In perennial species of *Paeonia* L. and *Sidalcea* A.Gray, the bi-parentally inherited, nrITS region has been used successfully to corroborate parentage of allopolyploid taxa (Sang et al. 1995; Whittall et al. 2000). In angiosperms, direct sequencing of the maternally inherited chloroplast may provide additional evidence of hybrid origin by identifying the maternal parent (Koontz et al. 2004). In *Arctostaphylos*, Wahlert (2005) sequenced five chloroplast regions (*trnL* intron and the intergenic spacers *atpB-rbcL*, *trnL-trnF*, *trnS-trnG* and *trnH-psbA*) for 12 morphologically divergent and geographically distant species. The resulting combined alignment was 1,836 base pairs (bp) long and had just three parsimony informative positions. Thus, direct sequencing of the chloroplast in *Arctostaphylos* could not be used to infer relationships or to confirm maternal parentage in hybrids species.

Different life history strategies in *Arctostaphylos* appear to influence the rate of speciation. In California's fire-prone chaparral communities, *Arctostaphylos* and *Ceanothus* L. (Rhamnaceae) are the only genera of sclerophyllous shrubs containing species that have evolved an obligate seeding mode of reproduction (Wells 1969). In these genera, in about two thirds of the species, adults are killed in response to fire and populations recover by recruitment from seed banks. Most chaparral shrubs re-sprout after a stand-replacing fire, but in species of *Arctostaphylos* and *Ceanothus*, seeds are stored in a persistent soil seed bank from which they germinate only after fire (Parker and Kelly 1990). Therefore, each post-fire generation of obligate seeders is a product of sexual reproduction, whereas facultative sprouters regenerate primarily from vegetative re-sprouts (but also to a lesser degree from seed) (Keeley & Keeley 1981). A higher rate of morphological diversification and local endemism for seeders is supported by the fact that ca. 70% of *Arctostaphylos* taxa are obligate seeders (Wells 1969). Generation-time theory predicts that taxa with shorter generation times will have higher rates of molecular evolution in neutral DNA regions compared to taxa with longer generation times (e.g., Andreasen & Baldwin 2001). For that reason, it is hypothesized that in *Arctostaphylos*, there will be a higher rate of interspecific ITS sequence variability among obligate seeders compared to facultative sprouters.

The primary goal of this study was to estimate the phylogeny of *Arctostaphylos* with extensive taxon sampling using nrITS sequences. Increased taxon sampling could refine species composition of each clade, might reveal additional subclades, and could allow for more rigorous testing of the monophyly of certain infrageneric taxa. In addition, we sought to corroborate hybrid origin in putative hybrid species and to test a hypothesis of higher rates of nucleotide substitution in obligate seeders compared to facultative sprouters.

MATERIALS AND METHODS

Taxon Sampling

The ingroup included a total of 98 accessions representing 83 unique taxa. The remaining 15 accessions were multiple samples of morphologically diverse and/or widely distributed species: *Arctostaphylos uva-ursi*, *A. patula* Greene, *A. pungens* HBK, *A. manzanita* Parry, *A. glandulosa* Eastw., and *A. tomentosa* (Pursh) Lindl. The outgroup contained six species representing the other five genera in the Arbutoideae. All sequences generated for this study were new, except for two accessions of *Arctostaphylos* and five outgroup taxa, which were downloaded from GenBank (Appendix 1). Taxonomy follows Wells (2000) with names, geographic origin, voucher specimen data, and GenBank accession numbers given in Appendix 1. All accessions sequenced for this study are represented by voucher specimens deposited at the Harry D. Thiers Herbarium at San Francisco State University (SFSU), except for *Arctous erythrocarpa*, which is deposited at MO.

DNA Extraction, PCR Amplification, and Sequencing

Genomic DNA was extracted from herbarium material using DNeasy™ Plant Mini Kits (QIAGEN Corp., Alameda, CA, USA). The nrITS region was amplified using *Arctostaphylos*-specific primers designed for this study (5' to 3'): ITS 4-M = GGAAGTAAAAGTCGTAACAAGG and ITS 5-M = CTGGGGTCGCAATCAAGG. PCR amplifications for the ITS region were carried out under the following conditions: an initial denaturation step (92°C, 2 min) followed by 35 cycles of denaturation (92°C, 30 sec), annealing (58°C, 30 sec), and elongation (72°C, 2 min), with a final extension step (72°C, 5 min). PCR amplifications were performed in 25 µl reactions containing 10–100 ng genomic DNA and 0.25 µl Expand Taq High Fidelity PCR System™ with buffer and Mg^{2+} (Roche Diagnostics, Indianapolis, IN, USA). PCR products were visualized on an agarose gel and purified using MO BIO UltraClean™ PCR Clean-up Kits (MO BIO Laboratories, Carlsbad, CA, USA). Cycle-sequencing reactions used the same primers, annealing temperature, and additive as for PCR and employed BigDye® fluorescent dye-labeled chemistry (BigDye Terminator Cycle Sequencing Kit, Applied Biosystems, Foster City, CA, USA). Cycle-sequenced products were separated and visualized on an ABI 377 DNA sequencer (Applied Biosystems, Foster City, CA, USA). When a polymorphic nucleotide position was detected, the taxon was sequenced a second time to confirm the polymorphism. DNA sequencing was performed at the San Francisco State University Conservation Genetics Laboratory.

Phylogenetic Analyses

Due to low rates of nucleotide substitution and few insertions/deletions, ITS sequences were easily aligned automatically using Sequencher version 4.1 (Gene Codes, Ann Arbor, MI, USA). Maximum parsimony (MP) analysis was conducted on two data sets: 1) the total data set for all 98 *Arctostaphylos* sequences, and 2) a reduced data set with 17 taxa removed that had polymorphic nucleotide positions. Forty-four ingroup taxa, which shared identical ITS sequences, were treated as a single "taxon" (the "Gray Leaf" haplotype), therefore the actual number of taxa in both MP analyses was 55 and 38, respectively. MP analyses used the heuristic search strategy of Olmstead and Palmer (1994) to search the tree space for multiple islands of shortest trees. This search strategy, as implemented in PAUP* ver. 4.0b10 (Swofford 2002), was carried out in four steps, with the saved trees from each step used as starting trees in subsequent searches: 1) 1,000 random addition sequence replicates, nearest neighbor interchange (NNI), MulTrees Off, 2) tree-bisection reconnection (TBR), MulTrees Off, 3) NNI, MulTrees On, and 4) TBR, MulTrees On. A strict consensus tree was calculated from the shortest trees saved from each search. Internal branch support of phylogenetic trees was estimated with 100 bootstrap (BS) replicates (Felsenstein 1985) using a full heuristic search with TBR branch swapping, MulTrees on, and 10 random stepwise addition replicates. Results from the BS analysis were summarized in a strict consensus tree. Nucleotide characters were equally weighted and unordered, and indels were treated as missing data.

RESULTS

The aligned sequence matrix for the 98 ingroup accessions and 6 outgroup taxa was 600 bp in length (0% missing data), with 127 variable positions and 62 parsimony informative characters. A one bp deletion at position 403 was detected for *Arctostaphylos malloryi* (W.Knight & Gankin) P.V.Wells, *A. nissenana* Merriam, and three subspecies of *A. viscida* Parry. Forty-four taxa shared an identical nrITS sequence—the "Gray Leaf" haplotype—and are listed in Appendix 2 (the phrase "Gray Leaf haplotype" is used throughout this study to refer to this shared sequence and does not imply a uniform morphology among taxa sharing this identical sequence). The uncorrected pairwise distances for the ingroup nrITS sequences ranged from 0 to 2.4%. Parsimony analysis of the complete ITS data set reached a maximum of 100,000 equally parsimonious trees of length 178 before ending initial tree generation, with a consistency index (CI) of 0.837 (0.753 excluding uninformative characters) and retention index (RI) of 0.881. A strict consensus tree (not shown) revealed a large polytomy and three small clades: 1) a clade of all six accessions of North American *A. uva-ursi* (58% BS), 2) a clade containing *A. pumila* Nutt. and *A. tomentosa* (1) (59% BS), and 3) a clade containing *A. mewukka* and *A. ohloneana* M.C.Vasey & V.T.Parker (90% BS).

Polymorphic nucleotide positions were detected in the sequence electropherograms from superimposed patterns of nucleotide additivity (SNAPs) and were confirmed in 17 taxa (18% of ingroup): *A. otayensis*, *A. pringlei* ssp. *drupacea* Parry (P.V.Wells), *A. mewukka*, *A. pilosula* (Jeps. & Wiesl.), *A. viscida* ssp. *viscida*, *A. manzanita* ssp. *manzanita* from Humboldt Co., CA, *A. manzanita* ssp. *roofii* (Gankin) P.V.Wells, *A. manzanita* ssp. *laevigata* (Eastw.) Munz, *A. manzanita* ssp. *bowermanii*, *A. pungens* from San Diego Co., CA, *A.* × *pacifica* Roof, *A. nissenana*, *A. edmundsii* J.T.Howell, *A. glandulosa* ssp. *glandulosa* from San Diego Co., CA, *A. myrtifolia*, *A. nummularia* (1) and *A. hispidula* Howell. The number of polymorphic nucleotide positions within an individual ranged from 1 to 6 (0.7% to 4.3% of variable positions). Of these 17 taxa, 12 are tetraploids and/or hybrids. In four putative hybrid-derived or introgressed taxa (*A. pringlei* ssp. *drupacea*, *A. manzanita* ssp. *roofii*, *A. manzanita* ssp. *laevigata*, and *A. hispidula*) sequence electropherograms showed near-perfect patterns of additivity between synapomorphic nucleotides of suspected parents and hybrids (Table 1).

A second MP analysis was conducted with the 17 taxa with polymorphic nucleotide positions removed. The resulting aligned sequence matrix had 126 variable positions with 56 parsimony informative characters. MP analysis of the reduced ITS data set recovered a two-clade topology in the strict consensus of 350 equally parsimonious trees (Fig. 1) (tree length = 169, CI = 0.817, CI excluding uninformative characters = 0.677, RI = 0.858). Clade 1 was weakly supported (55% BS) and Clade 2 was moderately well supported (77% BS). Within Clade 1, two subclades were recovered: 1) a clade containing the six accessions of *A. uva-ursi* (59% BS) and 2) a clade containing three subspecies of *A. stanfordiana* Parry, *A. nummularia* A.Gray, and *A. mendocinoensis* P.V.Wells (76% BS). In Clade 2, the Gray Leaf "taxon" representing the 44 taxa with identical sequences fell out in a polytomy while three clades were resolved: 1) *A. pungens* from Arizona, *A. australis*,

TABLE 1. Four putative hybrid taxa showing superimposed nucleotide additivity patterns (SNAPs) between suspected parents and hybrid offspring. $2n$ = ploidy level (26 = diploid, 52 = tetraploid). Numbers above bases indicate nucleotide position.

Taxon	Relationship	2*n*	Nucleotide position		
			54	363	556
A. glauca	parent	26	G	A	G
A. pringlei subsp. *drupacea*	hybrid	26	G/A	A/G	G/T
A. pringlei subsp. *pringlei*	parent	26	A	G	T
			121	154	
A. patula	parent	52	T	T	
A. manzanita subsp. *roofii*	hybrid	52	C/T	C/T	
A. manzanita subsp. *manzanita*	parent	52	C	C	
			121	154	
A. stanfordiana subsp. *stanfordiana*	parent	26	T	T	
A. manzanita subsp. *laevigata*	hybrid	52	C/T	C/T	
A. manzanita subsp. *manzanita*	parent	52	C	C	
			500		
A. viscida subsp. *viscida*	parent	26	C		
A. hispidula	hybrid	26	C/A		
A. stanfordiana subsp. *stanfordiana*	parent	26	A		

and *A. pringlei* subsp. *pringlei* (71% BS), 2) *A. pumila* and *A. tomentosa* subsp. *tomentosa* (65% BS), and 3) *A. malloryi* and *A. viscida* subsp. *mariposa* (59% BS).

Of the 44 species sharing an identical Gray Leaf haplotype, five are facultative sprouters (*A. glandulosa* ssp. *cushingiana*, *A. glandulosa* ssp. *glaucomollis*, *A. tomentosa* ssp. *daciticola*, *A. tomentosa* ssp. *insulicola*, and *A. tomentosa* ssp. *roseii*) and the rest are obligate seeders. The low variability of the nrITS region—and the fact that both obligate seeders and several sprouters shared an identical sequence—precluded a test of higher nucleotide substitution rates in seeders compared to sprouters.

DISCUSSION

The phylogeny inferred from the nrITS data sets reveals less resolution than had been expected for this morphologically diverse and widely distributed genus. The species composition of Clades 1 and 2 recovered in the MP analysis of the reduced nrITS data set is largely congruent with the two-clade molecular phylogenies of Markos et al. (1998) and Boykin et al. (2005), and the flavonoid phenogram of Denford (1981).

None of the subclades recovered in MP analyses have a discrete pattern of geographical distribution that can be mapped onto the phylogeny. Although the circumarctic distribution of *Arctostaphylos uva-ursi* is unique in the genus, this species is also distributed along the coastal areas and mountains of western North America where it co-occurs with other taxa (e.g., *A. columbiana* Piper, *A. imbricata* Eastw., *A. patula*). Neither are there discrete and readily interpretable morphological or cytological synapomorphies that can be mapped onto this phylogeny to support the present taxonomic groupings of Wells (2000) or the subclades that were recovered in the phylogenetic trees. Boykin et al. (2005) found that the character states of inflorescence bracts, bark, distribution of stomata, and ploidy level were not consistent with monophyly of certain infrageneric groups and that some states have arisen more than once in the genus. Because Wells' (2000) classification of *Arctostaphylos* is based on potentially homoplasious morphological characters, discordance between his classification and the nrITS phylogeny is not unexpected.

The occurrence of polymorphic nucleotide positions showing patterns of additivity between synapomorphic nucleotides of putative hybrids and suspected parents is suggestive of hybrid origin in four taxa (Table 1). However, many more polymorphic sites showing patterns of additivity between parents and hybrid offspring would be needed to confirm hybrid origin for the taxa in Table 1 (e.g., Sang et al. 1995). Such

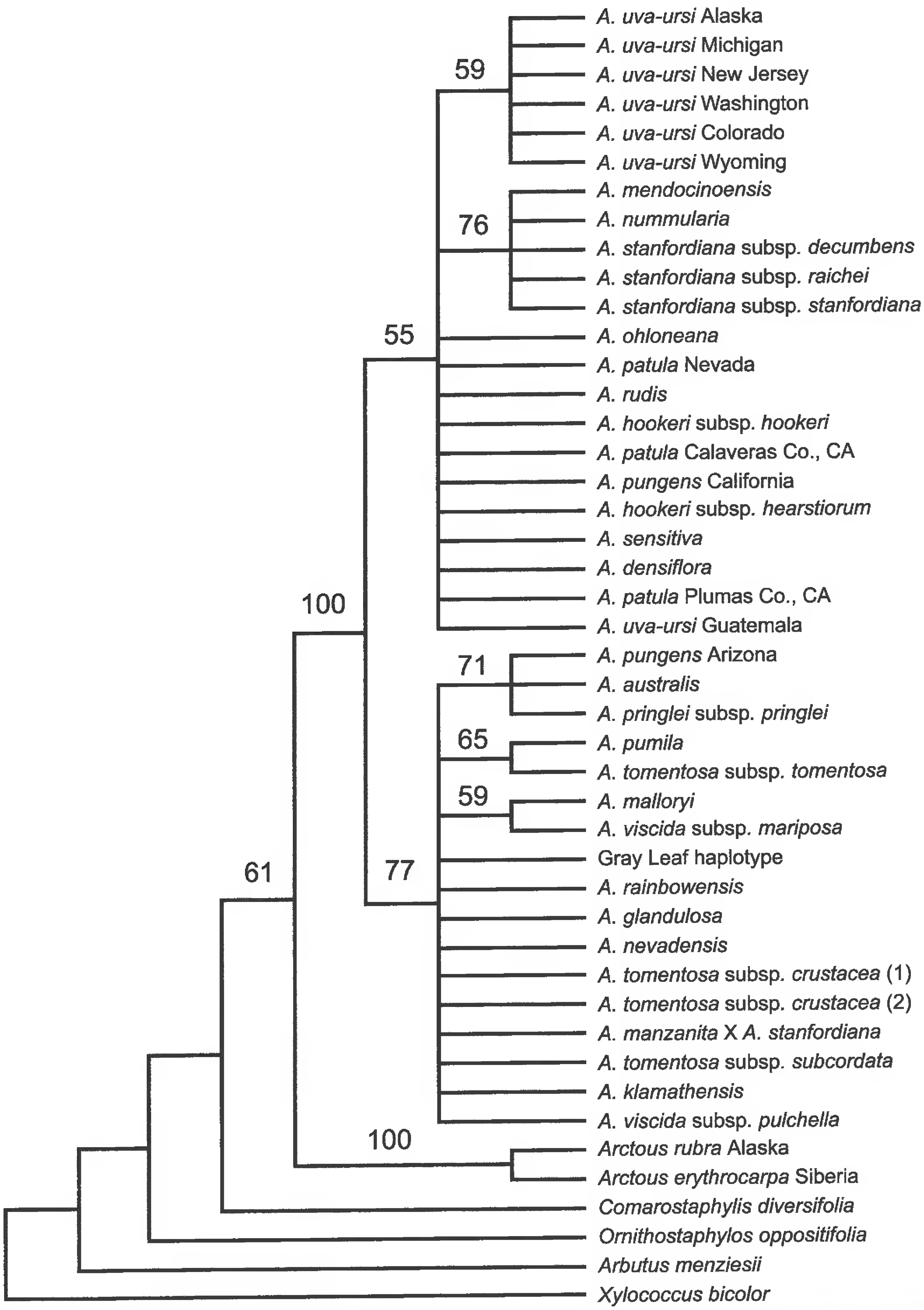

A. uva-ursi Alaska
A. uva-ursi Michigan
A. uva-ursi New Jersey
A. uva-ursi Washington
A. uva-ursi Colorado
A. uva-ursi Wyoming
A. mendocinoensis
A. nummularia
A. stanfordiana subsp. decumbens
A. stanfordiana subsp. raichei
A. stanfordiana subsp. stanfordiana
A. ohloneana
A. patula Nevada
A. rudis
A. hookeri subsp. hookeri
A. patula Calaveras Co., CA
A. pungens California
A. hookeri subsp. hearstiorum
A. sensitiva
A. densiflora
A. patula Plumas Co., CA
A. uva-ursi Guatemala
A. pungens Arizona
A. australis
A. pringlei subsp. pringlei
A. pumila
A. tomentosa subsp. tomentosa
A. malloryi
A. viscida subsp. mariposa
Gray Leaf haplotype
A. rainbowensis
A. glandulosa
A. nevadensis
A. tomentosa subsp. crustacea (1)
A. tomentosa subsp. crustacea (2)
A. manzanita X A. stanfordiana
A. tomentosa subsp. subcordata
A. klamathensis
A. viscida subsp. pulchella
Arctous rubra Alaska
Arctous erythrocarpa Siberia
Comarostaphylis diversifolia
Ornithostaphylos oppositifolia
Arbutus menziesii
Xylococcus bicolor
59
76
55
100
71
65
59
61
77
100

Fig. 1. Strict consensus of 350 most parsimonious trees estimated from nrITS sequences. The numbers above the branches are bootstrap percentages. The taxon "Gray Leaf haplotype" represents 44 taxa with an identical nrITS sequence (listed in Appendix 2).

polymorphisms suggest: 1) recent hybrid origin where both parental alleles are maintained in the hybrid progeny, 2) different alleles existing between parental genomes in tetraploids, 3) recently substituted nucleotides that have not been fully homogenized via concerted evolution, or 4) intra-individual nrITS paralogs (Wendel et al. 1995; Koontz et al. 2004; Bailey et al. 2003).

The 44 taxa sharing the Gray Leaf haplotype are morphologically diverse and are composed of both obligate seeders and facultative sprouters (Appendix 2). Sprouting species sharing the Gray Leaf haplotype are represented by five tetraploid taxa of the *Arctostaphylos glandulosa-tomentosa* complex, whereas most of the other taxa are diploid obligate seeders. As a result, a hypothesis of greater nrITS nucleotide substitution rates in short generation-time seeders vs. long generation-time sprouters could not be tested. These results suggest common ancestry of all "Gray Leaf" taxa, and by extension, the remaining taxa in Clade 2. If phylogenetic reconstruction of *Arctostaphylos* based on nrITS is an accurate inference of common ancestry, then there has been much diversification in the morphology, cytology, and ecological life-histories of taxa in Clade 2 without corresponding nrITS sequence divergence.

Resolving species-level phylogenies is difficult in perennial, reticulating, and putatively recently diversified genera such as *Arctostaphylos* and other genera containing species that are widely distributed and morphologically diverse (e.g., *Ceanothus* (Rhamnaceae), Hardig et al. 2000, *Leucaena* (Fabaceae), Bailey et al. 2004, *Inga* (Fabaceae), Richardson et al. 2001). Low interspecific sequence variability in the nrITS region in *Arctostaphylos* may be due several factors, including recent diversification in California since the end of the Miocene, long generation time between sexual reproduction events, genome homogenization via introgression, and rapid concerted evolution of nuclear ribosomal ITS arrays in both diploids and tetraploids.

The results from this study and others show that direct sequencing of the nrITS region and the chloroplast provide insufficiently variable DNA sequences needed to resolve phylogenetic relationships in *Arctostaphylos*. Other PCR-based techniques have been used in *Arctostaphylos* without success. For example, the presence of endophytic fungi in the sclerophyllous leaves of *Arctostaphylos* prevented the use of RAPDs (randomly amplified polymorphic DNAs) and inter-simple sequence repeats (ISSRs) (C. Reading, pers. comm., Wahlert unpubl. data). Another approach using RFLPs (restriction fragment length polymorphisms) of the chloroplast genome may prove useful in corroborating the hybrid origin of *A. mewukka* (K. Schierenbeck, pers. comm.). Bi-parentally inherited nuclear genes with adequate sequence variability are needed to estimate phylogeny in *Arctostaphylos*. Sequences from single- or low-copy nuclear genes or from anonymous nuclear regions using sequence characterized amplified regions (SCARs) may provide a means to resolve the phylogeny and to tease apart patterns of reticulation in *Arctostaphylos*. Until then, many fascinating questions of polyploidization, hybrid and ecological speciation, biogeography, and ecology will go unanswered in this remarkable genus.

APPENDIX 1

List of taxa used in this study with voucher specimen information and GenBank accession numbers for nrITS sequences. All vouchers are deposited in the Harry D. Thiers Herbarium at San Francisco State University (SFSU), except for *Arctous erythrocarpa*, which is deposited at MO. Numbers in parentheses indicate different accessions of the same taxon. * Denotes a sequence obtained from GenBank.

Outgroup. *Arbutus menziesii* Pursh*, AF086828; *Arctous rubra* (Rehder & E.H.Wilson) Nakai*, AF091944; *Arctous erythrocarpa* Small., Russian Siberia, MO accession number 5196245, GQ281006; *Comarostaphylis diversifolia* (Parry) Greene*, AF091947; *Ornithostaphylos oppositifolia* (Parry) Small*, AF297794 (ITS 1 and 5.8S), AF091962 (5.8S and ITS 2); *Xylococcus bicolor* Nutt.*, AF091948.

Ingroup. *Arctostaphylos andersonii* A.Gray, San Mateo Co., CA, USA, *V.T.Parker & M.C.Vasey 764*, GQ280910; *A. auriculata* Eastw., Contra Costa Co., CA, USA, *M.C.Vasey 840*, GQ280911; *A. australis* Eastw., Baja Norte, Mexico, *M.C.Vasey 799*, GQ280912; *A. bakeri* Eastw. subsp. *bakeri* Eastw., Sonoma Co., CA, USA, *M.C.Vasey 71*, GQ280913; *A. bakeri* subsp. *sublaevis* P.V.Wells, Sonoma Co., CA, USA, *V.T.Parker & M.C.Vasey 548*, GQ280914; *A. canescens* subsp. *canescens* Eastw., Marin Co., CA, USA, *V.T.Parker & M.C.Vasey 443*, GQ280915; *A. canescens* subsp. *sonomensis* (Eastw.) P.V.Wells, Lake Co., CA, USA, *M.C.Vasey 282*, GQ280916; *A. catalinae* P.V.Wells, Santa Barbara Co., CA, USA, *V.T.Parker & M.C.Vasey 155*, GQ280917; *A. columbiana* Piper, Humboldt Co., CA, USA, *M.C.Vasey 1030*, GQ280918; *A. confertiflora* Eastw., Santa Barbara Co., CA, USA, *V.T.Parker & M.C.Vasey 900*, GQ280919; *A. cruzen-*

sis Roof, San Luis Obispo Co., CA, USA, *V.T.Parker et al. 12*, GQ280920; *A. densiflora* M.S.Baker, Sonoma Co., CA, USA, *M.C.Vasey 69*, GQ280921; *A. edmundsii* J.T.Howell, Monterey Co., CA, USA, *M.C.Vasey 819*, GQ280922; *A. gabilanensis* V.T. Parker & M.C.Vasey, San Benito Co., CA, USA, *V.T.Parker & M.C.Vasey 1086*, GQ280923; *A. glandulosa* subsp. *cushingiana* (Eastw.) Adams ex McMinn, Santa Barbara Co, CA, USA, *M.C.Vasey 1002*, GQ280924; *A. glandulosa* subsp. *glandulosa* Eastw. (1), San Diego Co., CA, USA, *M.C.Vasey 724*, GQ280925; *A. glandulosa* subsp. *glandulosa* (2), San Benito Co., CA, USA, *V.T.Parker & M.C.Vasey 456*, GQ280926; *A. glandulosa* subsp. *glaucomollis* P.V.Wells, Los Angeles Co., CA, USA, *M.C.Vasey 1000*, GQ280927; *A. glauca* Lindl., Los Angeles Co., CA, USA, *M.C.Vasey 809*, GQ280928; *A. glutinosa* B.Schreib., Santa Cruz Co., CA, USA, *M.C.Vasey 401*, GQ280929; *A. hispidula* Howell, Del Norte Co., CA, USA, *M.C.Vasey 360*, GQ280930; *A. hookeri* subsp. *franciscana* (Eastw.) Munz, cultivated material; Strybing Arboretum, Golden Gate Park, San Francisco, CA, USA, GQ280931; *A. hookeri* subsp. *hearstiorum* (Hoover & Roof) P.V.Wells*, San Luis Obispo Co., CA, USA, AF106817; *A. hookeri* subsp. *hookeri* G.Don, Santa Cruz Co., CA, USA, *V.T.Parker & M.C.Vasey 55*, GQ280932; *A. hookeri* subsp. *montana* (Eastw.) P.V.Wells, Marin Co., CA, USA, *S. Markos 613*, GQ280933; *A. hookeri* subsp. *ravenii* P.V.Wells*, San Francisco Co., CA, USA, AF106819; *A. hooveri* P.V.Wells, Monterey Co., CA, USA, *M.C.Vasey 1050*, GQ280934; *A. imbricata* Eastw., San Mateo Co., CA, USA, *M.C.Vasey 18*, GQ280935; *A. insularis* Greene, Santa Barbara Co., CA, USA, *Anonymous s.n.*, GQ280936; *A. klamathensis* S.W.Edwards, Keeler-Wolf & W.Knight, Siskiyou Co., CA, USA, *M.C.Vasey 756*, GQ280937; *A. luciana* P.V.Wells, San Luis Obispo Co., CA, USA, *M.C.Vasey 1046*, GQ280938; *A. malloryi* (W.Knight & Gankin) P.V.Wells, Shasta Co., CA, USA, *V.T.Parker & M.C.Vasey 834*, GQ280939; *A. manzanita* subsp. *bowermanii* Roof, Contra Costa Co., CA, USA, *M.C.Vasey 169*, GQ280940; *A. manzanita* subsp. *elegans* (Jeps.) P.V.Wells, Glenn Co., CA, USA, *M.C.Vasey 216*, GQ280941; *A. manzanita* subsp. *glaucescens* P.V.Wells, Sonoma Co., CA, USA, *V.T.Parker & M.C.Vasey 508*, GQ280942; *A. manzanita* subsp. *laevigata* (Eastw.) Munz, Contra Costa Co., CA, USA, *M.C.Vasey 894*, GQ280943; *A. manzanita* subsp. *manzanita* Parry (1), Mendocino Co., CA, USA, *V.T.Parker & M.C.Vasey 369*, GQ280944; *A. manzanita* subsp. *manzanita* (2), Humboldt Co., CA, USA, *M.C.Vasey 851*, GQ280945; *A. manzanita* subsp. *manzanita* (3), Amador Co., CA, USA, *M.C.Vasey 767*, GQ280946; *A. manzanita* subsp. *manzanita* (4), Sonoma Co., CA, USA, *M.C.Vasey 424*, GQ280947; *A. manzanita* subsp. *roofii* (Gankin) P.V.Wells, Glenn Co., CA, USA, *M.C.Vasey 883*, GQ280948; *A. manzanita* × *A. stanfordiana*, Sonoma Co., CA, USA, *M.C.Vasey 425*, GQ280949; *A.* × *media* Greene, Mendocino Co., CA, USA, *M.C.Vasey 253*, GQ280950; *A. mendocinoensis* P.V.Wells, Mendocino Co., CA, USA, *G.Wahlert s.n.*, GQ280951; *A. mewukka* Merriam, Tuolumne Co., CA, USA, *M.C.Vasey 575*, GQ280952; *A. montaraensis* Roof, San Mateo Co., CA, USA, *M.C.Vasey 743*, GQ280953; *A. montereyensis* Hoover, Monterey Co., CA, USA, *M.C.Vasey 656*, GQ280954; *A. morroensis* Wiesl. & B. Schreib., San Luis Obispo Co., CA, USA, *K. Bode 823*, GQ280955; *A. myrtifolia* Parry, Amador Co., CA, USA, *M.C.Vasey 733*, GQ280956; *A. nevadensis* A.Gray, Siskiyou Co., CA, USA, *M.C.Vasey 757*, GQ280957; *A. nissenana* Merriam, Placer Co., CA, USA, *M.C.Vasey 892*, GQ280958; *A. nummularia* A.Gray, Mendocino Co., CA, USA, *V.T.Parker & M.C.Vasey 516*, GQ280959; *A. obispoensis* Eastw., Monterey Co., CA, USA, *M.C.Vasey 1052*, GQ280960; *A. ohloneana* M.C.Vasey & V.T.Parker, Santa Cruz Co., CA, USA, *V.T.Parker & M.C.Vasey 111*, GQ280961; *A. osoensis* P.V.Wells, San Luis Obispo Co., CA, USA, *K. Bode 780*, GQ280962; *A. otayensis* Wiesl. & Schreib., San Diego Co., CA, USA, *M.C.Vasey 748*, GQ280963; *A.* × *pacifica* Roof, San Mateo Co., CA, USA, *M.C.Vasey 20*, GQ280964; *A. pajaroensis* J.E.Adams, Monterey Co., CA, USA, *V.T.Parker & M.C.Vasey 459*, GQ280965; *A. pallida* Eastw., Alameda Co., CA, USA, *M.C.Vasey 436*, GQ280966; *A. patula* Greene (1), White Pine, Co., Nevada, USA, *M.C.Vasey 626*, GQ280967; *A. patula* (2), Plumas Co., CA, USA, *M. Wood 316*, GQ280968; *A. patula* (3), Calaveras Co., CA, USA, *V.T.Parker & M.C.Vasey 770*, GQ280969; *A. pilosula* Jeps. & Wiesl., San Luis Obispo Co., CA, USA, *M.C.Vasey 233*, GQ280970; *A. pringlei* subsp. *drupacea* Parry, Riverside Co., CA, USA, *M.C.Vasey 993*, GQ280971; *A. pringlei* subsp. *pringlei* Parry, Pima Co., Arizona, USA, *M.C.Vasey 232*, GQ280972; *A. pumila* Nutt., Monterey Co., CA, USA, *V.T.Parker & M.C.Vasey 677*, GQ280973; *A. pungens* HBK (1), San Bernardino Co., CA, USA, *M.C.Vasey 194*, GQ280974; *A. pungens* (2), San Diego Co., CA, USA, *M.C.Vasey 696*, GQ280975; *A. pungens* (3), Pima Co., Arizona, USA, *M.C.Vasey 228*, GQ280976; *A. purissima* P.V.Wells, Santa Barbara Co., CA, USA, *V.T.Parker et al. 2*, GQ280977; *A. rainbowensis* J.E.Keeley & Massihi, San Diego Co., CA, USA, *K. Bode 775*, GQ280978; *A. regismontana* Eastw., San Mateo Co., CA, USA, *M.C.Vasey 557*, GQ280979; *A.* × *repens* J.T.Howell, Marin Co., CA, USA, *V.T.Parker & M.C.Vasey 276*, GQ280980; *A. rudis* Jeps. & Wiesl., San Luis Obispo Co., CA, USA, *V.T.Parker & M.C.Vasey 151*, GQ280981; *A. sensitiva* Jeps., Marin Co., CA, USA, *V.T.Parker 306*, GQ280982; *A. silvicola* Jeps. & Wiesl., Santa Cruz Co., CA, USA, *V.T.Parker & M.C.Vasey 865*, GQ280983; *A. stanfordiana* Parry subsp. *decumbens* (P.V.Wells) P.V.Wells, Sonoma Co., CA, USA, *M.C.Vasey 422*, GQ280984; *A. stanfordiana* Parry subsp. *raichei* W.Knight, Mendocino Co., CA, USA, *M.C.Vasey 277*, GQ280985; *A. stanfordiana* Parry subsp. *stanfordiana*, Napa Co., CA, USA, *M.C.Vasey 392*, GQ280986; *A. tomentosa* subsp. *crustacea* (Eastw.) P.V.Wells (1), Monterey Co., CA, USA, *V.T.Parker 584*, GQ280987; *A. tomentosa* subsp. *crustacea* (2), Santa Cruz Co., CA, USA, *M.C.Vasey 786*, GQ280988; *A. tomentosa* subsp. *daciticola* P.V.Wells, San Luis Obispo Co., CA, USA, *M.C.Vasey 1008*, GQ280989; *A. tomentosa* subsp. *insulicola* P.V.Wells, Santa Barbara Co., CA, USA, *V.T.Parker & M.C.Vasey 903*, GQ280990; *A. tomentosa* subsp. *rosei* (Eastw.) P.V.Wells, Monterey Co., CA, USA, *M.C.Vasey 822*, GQ280991; *A. tomentosa* subsp. *subcordata* (Eastw.) P.V.Wells, Santa Barbara Co., CA, USA, *V.T.Parker & M.C.Vasey 901*, GQ280992; *A. tomentosa* subsp. *tomentosa* Pursh, Monterey Co., CA, USA, *M.C.Vasey 243*, GQ280993; *A. uva-ursi* (L.) Spreng., Ocean Co., New Jersey, USA, *V.T.Parker 437*, GQ280994; *A. uva-ursi*, Sleeping Bear National Lakeshore, Michigan, USA, *McEaghan 933*, GQ280995; *A. uva-ursi*, Yellowstone National Park, Wyoming, USA, *V.T.Parker & M.C.Vasey 942*, GQ280996; *A. uva-ursi*, Gunnison Co., Colorado, USA, *M.C.Vasey 643*, GQ280997; *A. uva-ursi*, Alaska, USA, *J. Bishop 684*, GQ280998; *A. uva-ursi*, Clallam Co., Washington, USA, *M.C.Vasey 340*, GQ280999; *A. uva-ursi* subsp. *cratericola* (J.D.Smith) P.V.Wells, cultivated material from Guatemala, U.C. Botanical Garden, 92-0545, GQ281000; *A. virgata* Eastw., Marin Co., CA, USA, *M.C.Vasey 783*, GQ281001; *A. viscida* subsp. *mariposa* (Dudley) P.V.Wells, Tuolumne Co., CA, USA, *M.C.Vasey 499*, GQ281002; *A. viscida* subsp. *pulchella* (Howell) P.V.Wells, Sonoma Co., CA, USA, *M.C.Vasey*

470, GQ281003; *A. viscida* subsp. *viscida* Parry, Eldorado Co., CA, USA, *V.T.Parker & M.C.Vasey 849*, GQ281004; *A. wellsii* W.Knight, San Luis Obispo Co., CA, USA, *M.C.Vasey 1041*, GQ281005.

APPENDIX 2

Forty-four taxa with identical nrITS sequences (i.e., the "Gray Leaf" haplotype).

Arctostaphylos andersonii, A. auriculata, A. bakeri ssp. *bakeri, A. bakeri* ssp. *sublaevis, A. canescens* ssp. *canescens, A. canescens* ssp. *sonomensis, A. catalinae, A. columbiana, A. confertiflora, A. cruzensis, A. gabilanensis, A. glandulosa* ssp. *cushingiana, A. glandulosa* ssp. *glaucomollis, A. glauca, A. glutinosa, A. hookeri* ssp. *franciscana, A. hookeri* ssp. *montana, A. hookeri* ssp. *ravenii, A. hooveri, A. imbricata, A. insularis, A. luciana, A. manzanita* ssp. *elegans, A. manzanita* ssp. *glaucescens, A. manzanita* ssp. *manzanita (1), A. manzanita* ssp. *manzanita (3), A. manzanita* ssp. *manzanita (4), A.* × *media, A. montaraensis, A. montereyensis, A. morroensis, A. obispoensis, A. osoensis, A. pajaroensis, A. pallida, A. purissima, A. regismontana, A.* × *repens, A. silvicola, A. tomentosa* ssp. *daciticola, A. tomentosa* ssp. *insulicola, A. tomentosa* ssp. *roseii, A. virgata, A. wellsii.*

ACKNOWLEDGMENTS

We thank Robert Patterson (SFSU) and Harvey Ballard, Jr. (Ohio University) for reviewing this manuscript and providing comments that improved it. David Keil (Cal Poly State University) and an anonymous reviewer also provided helpful commentary that enhanced the paper. Frank Cipriano (Conservation Genetics Lab, SFSU) and Juniper Scribner provided assistance with sequencing. Oriane Hidalgo (Ohio University) translated the abstract into Spanish.

REFERENCES

Andreasen, K. and B.G. Baldwin. 2001. Unequal evolutionary rates between annual and perennial lineages of checker mallows (*Sidalcea*, Malvaceae): evidence from 18S-26S rDNA internal and external transcribed spacers. Molec. Biol. Evol. 18:936–944.

Axelrod, D.I. 1989. Age and origin of chaparral. In S.C. Keeley, ed. The California chaparral: paradigms reexamined. Natural History Museum of Los Angeles County, Science Series, no. 34, Los Angeles, CA. Pp. 7–19.

Bailey, C.D., T.G. Carr, S.A. Harris, and C.E. Hughes. 2003. Characterization of angiosperm nrDNA polymorphism, paralogy, and pseudogenes. Molec. Phylogen. Evol. 29:435–455.

Bailey, C.D., C.E. Hughes, and S.A. Harris. 2004. Using RAPDs to identify DNA sequence loci for species level phylogeny reconstruction: an example from *Leucaena* (Fabaceae). Syst. Bot. 29:4–14.

Boykin, L.M., M.C. Vasey, and V.T. Parker. 2005. Two lineages of *Arctostaphylos* (Ericaceae) identified using the internal transcribed spacer (ITS) region of the nuclear genome. Madroño 52:139–147.

Brockmann, C., A.K. Brysting, I.G. Alsos, L. Borgen, H.H. Grundt, A.-C. Scheen, and R. Elven. 2004. Polyploidy in arctic plants. Biol. J. Linn. Soc. 82:521–536.

CNPS. 2009. California Native Plant Society. Inventory of rare and endangered plants. Online version 7-09a. <http://cnps.web.aplus.net/cgi-bin/inv/inventory.cgi>

Denford, K.E. 1981. Chemical subdivisions within the genus *Arctostaphylos* based on flavonoid profiles. Experientia 37:1287–1288.

Diggs, G.M. and G.J. Breckon. 1981. Systematic studies in the Arbuteae (Ericaceae, Vaccinioideae) including a revision of the genus *Comarostaphylis*. Ph.D. Dissertation. The University of Wisconsin-Madison, WI.

Dobzhansky, T. 1953. Natural hybrids of two species of *Arctostaphylos* in the Yosemite region of California. Heredity 7:73–79.

Edwards, S.W. 2004. Paleobotany of California. Four Seasons 12:3–75.

Felsenstein, J. 1985. Confidence limits on phylogenies: an approach using the bootstrap. Evolution 39:783–791.

Gottlieb, L.D. 1968. Hybridization between *Arctostaphylos viscida* and *A. canescens* in Oregon. Brittonia 2:83–93.

Hardig, T.M., P.S. Soltis, and D.E. Soltis. 2001. Diversification of the North American shrub genus *Ceanothus* (Rhamnaceae): conflicting phylogenies from nuclear ribosomal DNA and chloroplast DNA. Amer. J. Bot. 87:108–123.

Keeley, J.E. and A. Massihi. 1994. *Arctostaphylos rainbowensis*, a new burl-forming manzanita from northern San Diego County, California. Madroño 41:1–12.

Keeley, J.E. and S.C. Keeley. 1981. Post-fire regeneration of Southern California chaparral. Amer. J. Bot. 68: 524–530.

Kelly, V.R. and V.T. Parker. 1990. Seed bank survival and dynamics in sprouting and nonsprouting *Arctostaphylos* species. Amer. Midland Naturalist 124:114–123.

Knight, W. 1985. A new glandular manzanita in the southern inner north coast ranges of California. Four Seasons 7:17–20.

Koontz, J.A., P.S. Soltis, and D.E. Soltis. 2004. Using phylogeny reconstruction to test hypotheses of hybrid origin in *Delphinium* Section *Diedropetala* (Ranunculaceae). Syst. Bot. 29:345–357.

Kron, K.A., W.S. Judd, P.F. Stevens, D.M. Crayn, A.A. Anderberg, P.A. Gadek, C.J. Quinn, and J.L. Luteyn. 2002. Phylogenetic classification of Ericaceae: molecular and morphological evidence. Bot. Rev. 68:335–423.

Kruckeberg, A.R. 1977. Manzanita (*Arctostaphylos*) hybrids in the Pacific Northwest: effects of human and natural disturbance. Syst. Bot. 2:233–250.

Markos, S., L.C. Hileman, M.C. Vasey, and V.T. Parker. 1998. Phylogeny of the *Arctostaphylos hookeri* complex (Ericaceae) based on nrDNA data. Madroño 45:187–199.

Olmstead, R.G. and J.D. Palmer. 1994. Chloroplast DNA systematics: a review of methods and data analysis. Amer. J. Bot. 81:1205–1224.

O'Neil, S.E. and V.T. Parker. 2005. Factors contributing to the seed bank size of two obligate seeding *Ceanothus* species in Northern California. Madroño 52:182–190.

Parker, V.T. and M.C. Vasey. 2004. *Arctostaphylos gabilanensis* (Ericaceae), a newly described auriculate-leaved manzanita from the Gabilan Mountains, California. Madroño 51:322–325.

Raven, P.H. and D.I. Axelrod. 1978. Origin and relationships of the California flora. Univ. Calif. Publ. Bot. 72:1–134.

Richardson, J.E., R.T. Pennington, T.D. Pennington, and P.M. Hollingsworth. Rapid diversification of a species-rich genus of Neotropical rain forest trees. Science 293:2242–2245.

Rieseberg, L.H. 1995. The role of hybridization in evolution: old wine in new skins. Amer. J. Bot. 82:953–944.

Rosatti, T.J. 1981. A new chromosome number in *Arctostaphylos uva-ursi*. Canad. J. Bot. 59:272–273.

Sang, T., D.J. Crawford, and T.F. Stuessy. 1995. Documentation of reticulate evolution in peonies (*Paeonia*) using internal transcribed spacer sequences of nuclear ribosomal DNA: implications for biogeography and concerted evolution. Proc. Natl. Acad. Sci. U.S.A. 92:6813–6817.

Schmid, R., T. E. Mallory, and J. M. Tucker. 1968. Biosystematic evidence for hybridization between *Arctostaphylos nissenana* and *A. viscida*. Brittonia 20:34–43.

Schierenbeck, K.A., G.L. Stebbins, and R.W. Patterson. 1992. Morphological and cytological evidence for polyphyletic allopolyploidy in *Arctostaphylos mewukka* (Ericaceae). Pl. Syst. Evol. 179:187–205.

Swofford, D.L. 2002. PAUP*. Phylogenetic analysis using parsimony (* and other methods). Version 4.0b10. Sinauer Associates, Sunderland, MA.

Wahlert, G.A. 2005. A phylogeny of *Arctostaphylos* (Ericaceae) inferred from nuclear ribosomal ITS sequence data. Master's thesis. San Francisco State University, San Francisco, CA.

Wells, P.V. 1969. The relation between mode of reproduction and extent of speciation in woody genera of the California chaparral. Evolution 23:264–267.

Wells, P.V. 2000. The manzanitas of California, also of Mexico and the World. Published by the author.

Wendel J.F., A. Schnabel, and T. Seelanan. 1995. Bidirectional interlocus concerted evolution following allopolyploid speciation in cotton (*Gossypium*). Proc. Natl. Acad. Sci. U.S.A. 92:280–284.

Whittall, J., A. Liston, S. Gisler, and R.J. Meinke. 2000. Detecting nucleotide additivity from direct sequences is a SNAP: an example from *Sidalcea* (Malvaceae). Pl. Biol. 2:1–7.

THE REINSTATEMENT OF *BEAUTEMPSIA* (CAPPARACEAE) AND A KEY TO THE GENERA OF NEOTROPICAL CAPPARACEAE WITH VARIOUSLY STELLATE OR PELTATE INDUMENTA

Xavier Cornejo

The New York Botanical Garden
200th St. and Kazimiroff Avenue
Bronx, New York 10458-5126, U.S.A.
xcornejo@nybg.org,
xcornejoguay@gmail.com

Hugh H. Iltis

Department of Botany,
University of Wisconsin
430 Lincoln Drive,
Madison, Wisconsin 53706, U.S.A.
swis@charter.net

ABSTRACT

Beautempsia (Benth. & Hook. f.) Gaudich. is resurrected as a monospecific genus of neotropical Capparaceae. It is represented only by *Beautempsia avicenniifolia* (Kunth) Alleiz., a species restricted to the very dry woodlands and thorn scrub of western Ecuador and deserts in Peru. Its basionym *Capparis avicenniifolia* Kunth and its synonym *Capparis ovalifolia* Ruiz & Pav. ex DC. are lectotypified. The studied specimens are fully cited, and a key to the neotropical genera of Capparaceae with variously stellate or peltate indumenta is provided.

KEY WORDS: *Beautempsia*, Capparaceae, coastal dry forests, Ecuador, Peru

RESUMEN

Resucitamos *Beautempsia* (Benth. & Hook. f.) Gaudich., un género neotropical de Capparaceae, únicamente representado por *Beautempsia avicenniifolia* (Kunth) Alleiz., una especie restringida a los matorrales muy secos del occidente de Ecuador y los desiertos de Perú. Se lectotipifican a su basónimo *Capparis avicenniifolia* Kunth, y a su sinónimo *Capparis ovalifolia* Ruiz & Pav. ex DC. Se citan los especímenes estudiados de esta especie y se presenta una clave para los géneros neotropicales de Capparaceae que tienen indumento estrellado de varios tipos o peltado.

PALABRAS CLAVE: *Beautempsia*, Capparaceae, bosques secos costeros, Ecuador, Perú

Beautempsia was proposed by Gaudichaud (1842) as a new generic name with a single species based on *Capparis avicenniifolia* Kunth (1821), a distinctive species of neotropical Capparaceae, restricted to the very dry woodlands and thorn scrub of western Ecuador and deserts in Peru. Hindered by ill health (Johnston 1944), Gaudichaud was able to only publish plate 56 with the name *Beautempsia avicenniaefolia*, without text. Gaudichaud's plate 56 consists of a leafy branch bearing inflorescences and a fruit, and a detailed group of separate figures, all without captions or descriptions (Fig. 1). Therefore, *Beautempsia* Gaudich. (1842) is not valid because Art. 41.2 of the ICBN (McNeill et al. 2006) states, a description or diagnosis is required for valid publication of a genus.

Subsequently, Bentham and Hooker f. (1862: 109) formally established *Beautempsia* as a section of *Capparis*, with a short latin description, citing "Gaud. Voy. Bonite, t. 56," and without citation of any type species. That is the earliest legitimate name that has priority and must be followed in accordance with Arts. 41.2, 45.1, 45.3 of ICBN (McNeill et al. 2006). Three years later Eichler, in Martius' Flora Brasiliensis (1865: 267, 269), raised it to *Capparis* subg. *Beautempsia*, citing Bentham & Hook f., "Gaud. Voy. Bonite t. 56," with a Latin diagnosis, and only represented by a single species, *Capparis avicenniifolia*. The respective captions for Gaudichaud's plate 56 were published in French 14 years after the publication of Gaudichaud's Atlas, 12 years after Gaudichaud's death, and after the Bentham and Hooker f. establishment of *Capparis* sect. *Beautempsia*. That work (Gaudichaud 1866) was accomplished with the collaboration of Charles D'Alleizette, who provided explications and descriptions for the plates, validating the generic name and the respective new combination (Gaudichaud 1842). Although Gaudichaud (1842, 1866) did not cite the basionyms, Art. 33.3 of the ICBN support them as valid taxa those published before Jan 1953.

Hutchinson (1967: 307) attempted to realign the taxonomy of the genus *Capparis*, and correctly re-

J. Bot. Res. Inst. Texas 3(2): 683 – 689. 2009

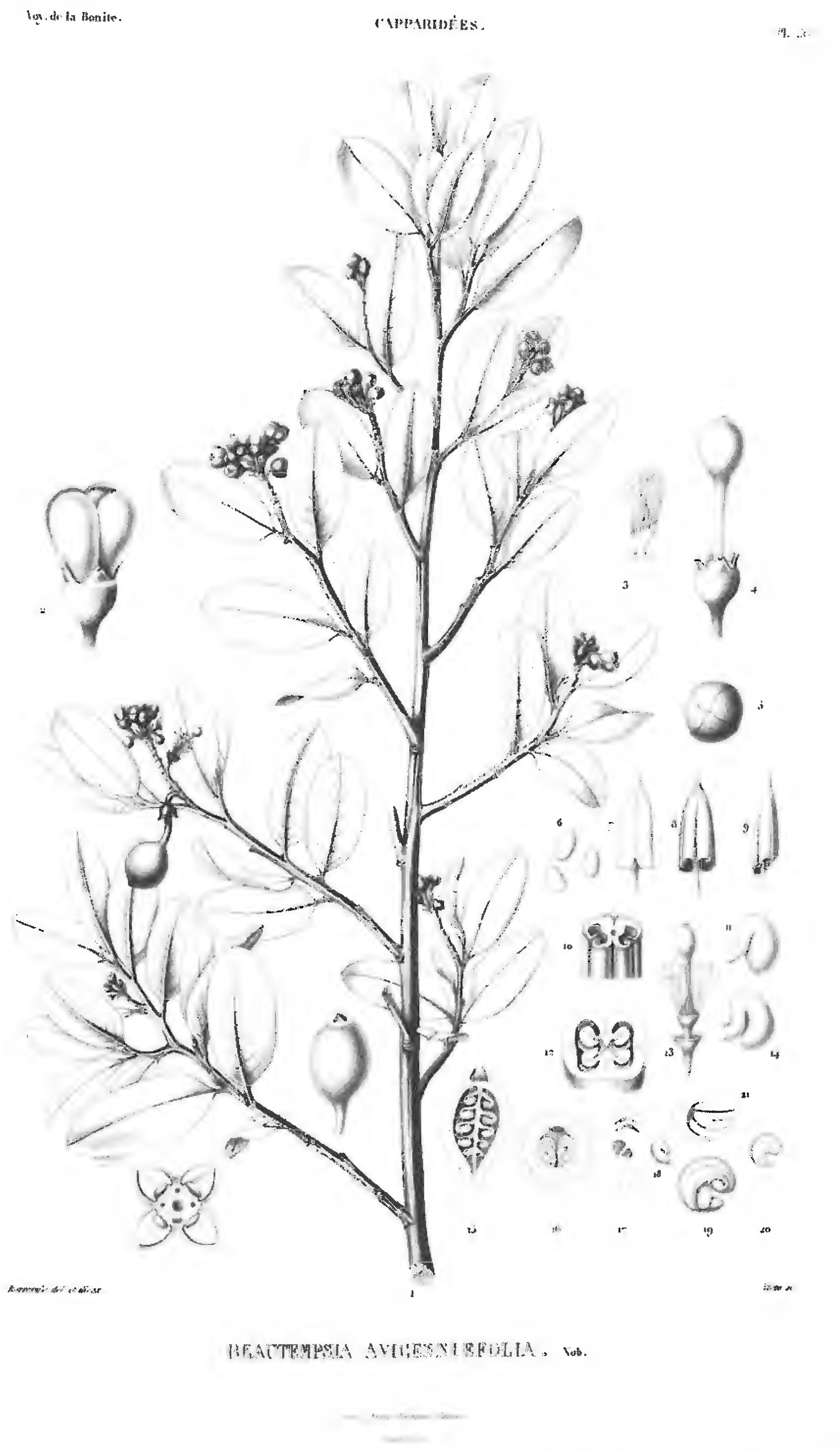

Voy. de la Bonite.
CAPPARIDÉES.
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
BEAUTEMPSIA AVICENNIÆFOLIA, Vob.

Fig. 1. ***Beautempsia avicenniifolia*** **(Kunth) Alleiz. Plate 56 reproduced from Gaudichaud's Atlas (1842). 1. Branch. 2. Flower. 3. Androphore and stamens. 4. Young fruit. 5. Flower bud, adaxial view. 6. Pollen grains. 7–9. Anthers, dorsal, ventral and lateral views. 10. Cross section of anther. 11. Ovules. 12. Cross section of ovary. 13. Pistil and stamens. 14. Ovules. 15. Longitudinal section of ovary. 16. Cross section of fruit. 17. Longitudinal section of young fruit. 18. Seed. 19. Embryo. 20. Longitudinal section of fruit. 21. Longitudinal section of embryo.**

garded *Beautempsia* as a valid genus. In this paper, *Beautempsia* is again recognized as a neotropical genus of Capparaceae.

Beautempsia (Benth. & Hook. f.) Gaudich., Voy. Bonite, Bot. 4:38. 1866. TYPUS: *Capparis avicenniifolia* Kunth. BASIONYM: *Capparis* sect. *Beautempsia* Benth. & Hook. f., Gen. Pl. 1:109. 1862. *Capparis* subg. *Beautempsia* (Benth. & Hook. f.) Eichl. in Mart., Fl. Bras. 13(1):276. 1865. *Beautempsia* Gaudich., Voy. Bonite, Bot. 3 (Atlas), pl. 56. 1842, nom. inval.

Unarmed shrubs or small trees, with stellate trichomes throughout. Leaves simple, spirally arranged, with petioles of similar length, lacking a pulvinus and stipules. Inflorescences terminal short racemes; flowers pedicellate, zygomorphic, linear-bracteate, the bracts soon deciduous, the flowerbuds globose-obovate just preceding anthesis. Calyx with open aestivation, gamosepalous, hemisphaerical-cyathiform, tetralobulate to slightly tetracrenate or subtruncate. Hypanthium present. Nectary scales 4, deltoid, mostly free, fused at the base, rounded at the apex. Corolla spirally twisted (torsivus), petals 4, unguiculate, sessile. Stamens 16 to 18, the outer provided with short staminal nectaries at base of filaments, the inner with glandular tissue at base of filaments, all perfectly articulated with each other at the base, and forming a nectariferous dish-shaped digitate pseudotorus supported by a common androphore. At anthesis the stamens project outward and arch upward, with the gynophore abaxially strongly off-center. Ovary 2-locular. Fruits small pepos (1–)2–4 × 1–2 cm, containing a sticky orange pulp (in vivo); seeds cochlate-reniform, rounded to bean-shaped, slightly flattened laterally, the testa light brown (in vivo), with a sarcotesta infiltrated by hairs, the cotyledons convolute, the embryo white.

Etymology.—The generic name is formed by the French adjective beau, which means beautiful, and the French noun temps, which means weather. That refers to the beautiful weather that impressed Gaudichaud during his visit to the coast of Peru where he found this genus.

Beautempsia is characterized by stellate trichomes, gamosepalous hemisphaerical-cyathiform calyces with very short to highly reduced lobes, presence of staminal nectaries articulated to the base of the filaments, forming a nectariferous dish-shaped digitate pseudotorus, and pepo fruits.

Due to the presence of relatively small zygomorphic flowers with off center gynophores, unguiculate petals, hypanthium, and seeds with white embryo, covered by a sarcotesta, *Beautempsia* resembles *Atamisquea* Miers, another bee-pollinated and xerophytic specialized monotypic genus (Cornejo & Iltis 2008). But the latter mainly differs from *Beautempsia* by the presence of 2-seriate calyces with well developed dimorphic decussate sepals (vs. calyces 1-seriate with small or reduced lobes), ovary at the apex and style sharply acute to subrostrate (vs. ovary at the apex thick, without style and with the stigma capitate, sessile), and the absence (vs. presence) of a dish-shaped pseudotorus.

This is a monospecific genus restricted to the dry coastal woodlands and thorn scrub of Ecuador and deserts in Peru. It is represented by the following species.

Beautempsia avicenniifolia (Kunth) Gaudich. ['avicenniaefolia'], Voy. Bonite, Bot. 4:38. 1866. (**Fig. 1**). BASIONYM: *Capparis avicenniifolia* Kunth ['avicennifolia'], Nov. Gen. Sp. 5:94. 1821. *Colicodendron avicenniifolium* (Kunth) Seemann ['avicenniaefolium'], Bot. H.M.S. Herald 1:78. 1853. TYPE: PERU: "Crescit in litore arenoso Maris Pacifici, inter Cascas et Trujillo Peruvianorum, Floret Augusto," *Humboldt & Bonpland 3722* (LECTOTYPE, here designated: P; DUPLICATES OF THE LECTOTYPE: B-10 0242517 [WIS photo]).

Capparis ovalifolia Ruiz & Pav. ex DC., Prodr. 1:253. 1824. *Capparis ovalifolia* Ruiz & Pav. ex E.A. López, Ann. Inst. Bot. A.J. Cavanilles 16:384, fig. 432a. 1958, nom. illegit. TYPE: ECUADOR. PROV. GUAYAS: [*Huayaquil*], Morro, 1803, *J. Tafalla (=Ruiz) s.n.* (LECTOTYPE, here designated: MA).

Specimens examined: **ECUADOR. Manabí:** Bahía de Caráquez, 12 May 1968, *Harling et al. 9454* (GB, US, WIS); Punta de Jaramijó, ca. 7 m, 5 May 1985, *Harling & Andersson 24852* (GB, NY, QCA, WIS); Manta, 6 Apr 1955, *Asplund 15972* (B, LD, NY, S, TEX, Z); vicinity of Manta, 80°41'W, 0°57'S, ca. 5 m, 1 Oct 1985, *Madsen 61025* (AAU, QCA, QCNE); 14 km SW of Manta on new road to San Lorenzo, 80°47'W 1°01'S, 300 m, 2 Jun 1997, *Neill & Asanza 10708* (DAV, MO, QCNE, WIS); Vía Rocafuerte-Manta, bosque de La Armada, 80°44'W, 0°7'S, 10 m, 24 Nov 1992, *Alvarez (collected by Mosquera) 747* (AAU, MO, QCNE); road Montecristi-Jipijapa, 13 May 1968, *Harling et al. 9488* (GB, GH, QCA, WIS); 20 km N of Jipijapa, *Pennington & Tenorio 10696* (K, QCA, QCNE); 6 km SW of Jipijapa on road to Cayo, río seco de Jipijapa drainage, 225 m, 2 Nov 1965, *Anderson 2501* (RSA, WASH); Machalilla National Park, Playa Los Frailes, 80°44'W, 1°31'S, 125 m, 4 Aug 1990, *Cerón et al. 11760* (MO, QCNE, WIS); 5 m, 23 Jan 1991, *Gentry & Josse 72701* (MO, QCNE); km 19, bosque muy seco tropical, ca. 30 m, Aug 1994, *Bonifaz & Cornejo 2447* (GUAY); Isla de La Plata, 81°13'W, 1°16'S, 26–27 Jun 1973, *Holm-Nielsen et al. 7286* (AAU, NY, QCNE); 81°04'W, 1°17'S, ca. 25 m, 5 Feb 1992, *Josse 760* (AAU); 81°06'W, 1°18'S, ca. 35 m, 18 Aug 1993, *Núñez 127* (MO, QCNE); 81°04'W 1°17'S, ca. 60 m, 6 Apr 1991, *Cerón et al. 13986* (QCNE); 81°06'W 0°26'S, 70 m, 21 Nov 1993, *Woodruff & Núñez 580* (NY, QCNE). **Guayas:** Guayaquil, 1841, *Hinds s.n.* (K [in Sinclair Bot. Voy. Sulphur]); Colonche, 2 May 1956, *Asplund 20404* (NY, S, TEX, US); Manglaralto, ca. 5 m, 10 Feb 1966, *Sánchez 10* (GUAY, WIS); between Salinas and Manglaralto, 19 Nov 1952, *Fagerlind & Wibom 208* (LD, MO); Punta Ayangue, 80°46'W 1°57'S, 19 Mar 1941, *Svenson 11343* (BKL); Ayangue, 10 m, 26 Oct 2007, *Cornejo & Grochowski 7998* (GUAY, NY [sample for DNA studies]); a la entrada de Ayangue, entre Palmar y Valdivia, Aug 1980, *Valverde 4826* (GUAY, SEL, MO); small hill at Pacoa, 10 km N of San Pablo, ca. 2 km from the shore, 80°45'W, 2°06'S, ca. 50 m, 26 Mar 1973, *Holm-Nielsen et al. 2532* (AAU, MO, NY); Salinas, 80°58'W, 2°13'S, 0 m, 2 Nov 1983, *Barford et al. 48448* (AAU, QCNE, WIS); road Guayaquil-Salinas, km 2–3 W of Progreso, 80°25'W, 2°23'S, 100 m, 4 Feb 1987, *Bohlin et al. 1167* (GB, QCA); km 89–90 from Guayaquil, just E of village of Buenos Aires, 35 m, 17 Jul 1986, *Plowman & Alcorn 14312* (F, QCA, WIS); km 80 W of Guayaquil, 25 Aug 1965, *Játiva & Epling 914* (LA, NY); along highway 17 km W of Progreso (Gómez-Rendón), 12 km E of Zapotal, 80°30'W, 2°22'S, ca. 100 m, 25 Jun 1977, *Iltis & Iltis E-1* (QCA, WIS). ca. 2.5 km SE of Salinas, just S of highway to Santa Elena, 80°57'W, 2°12'S, 2 m, 26 Jun 1977, *Iltis & Iltis E-20* (QCA, WIS); Punta de Santa Elena, 81°W, 2°12'S, 21 Mar 1973, *Holm-Nielsen et al. 2353* (AAU); between Santa Elena and Punta Blanca, 80°50'W, 2°11'S, 22 Mar 1973, *Holm-Nielsen et al. 2402* (AAU); between Santa Elena and Ancón, 80°49'W, 2°13'S, 26 Feb 1941, *Svenson 11171* (BKL, GH, NY, US); 4–6 km S of Santa Elena on road to Ancón, sea level, 18 Feb 1974, *Gentry 10010* (MO, WIS); near Ancón, 25 Aug 1965, *Játiva & Epling 916* (LA); Lado sur de Península Santa Elena, entre Punta Ancón y Atahualpa, 30 m, 19 Feb 1982, *Baslev 2242* (GH, NY, QCA, QCNE); Chanduy, *in litore Maris Pacifi*, Jun 1862, *Spruce 6402* (BM, CGE, K, LE, OXF, P); 1 km NW of Chanduy towards Atahualpa, 80°41'W, 2°23'S, ca. 5 m, 18 Mar 1973, *Holm-Nielsen et al. 2147* (AAU, NY); Punta Carnero, 0 m, 20 May 1981, *Dodson & Clendenin 10994* (MO, QCNE, SEL, WIS); Pacific coast inmediately W of Punta Carnero, 80°55'W, 2°15'S, 17 Mar 1973, *Holm-Nielsen et al. 2000* (AAU, MO, NY, QCNE, WIS); 400 m E of Punta Carnero, 80°55'W, 2°15'S, 17 Mar 1973, *Holm-Nielsen et al. 2052* (AAU, MO, NY, S); Vía Playas—Posorja, May 1978, *Valverde 2541* (GUAY, MO, SEL); Ayalán, 80°20'W, 2°40'S, 1 Mar 1990, *Bonifaz 682* (GUAY, WIS); Morro, cercanías, 5 m, 20 Aug 2002, *Cornejo 7585* (AAU, COL, GUAY, MO, QCA, QCNE, US, WIS [sample for DNA studies]); Isla Puná, Puná Nueva to Santa Teresa, 79°57'W, 2°43'S, 0 m, 3 Dec 1987, *Madsen 64140* (AAU, QCA, QCNE, MO); midway between Puná Nueva and Zapote, 79°56'W, 2°44'S, 0 m, 3 Sep 1987, *Madsen 63879* (AAU, K, MO, NY, QCA, QCNE); Zapote to Estero de Lagarto, 79°57'W, 2°43'S, 0 m, 4 Aug 1987, *Madsen 63826* (AAU, GUAY, K, MO, NY, QCA, QCNE); entre Puerto Grande y Puná Nueva, 80°7'W, 2°57'S, 0 m, 8 Jul 1995, *Jaramillo 18175* (QCA); Insula Puna, Oct 1892, *Eggers 14756* (GH, LE, M, US, K); ibidem, *Mille 785* (US). **El Oro:** ca. 1 km N of Huaquillas, 1 May 1980, *Harling & Andersson 18812* (GB, QCA, WIS); Huaquillas, 14 Mar 1955, *Asplund 15743* (S, LD, NY); entre Huaquillas y Arenillas, al lado de la carretera, 15 Apr–15 May 1979, *Albert de Escobar 1262* (QCA, WIS); Isla Santa Clara o del Muerto, 80°28'W, 3°12'S, ca. 30 m, 4 May 1997, *Vargas & Canaday 1444* (MO, NY, QCNE, WIS); Isla Bellavista, 80°13'15"W, 3°24'40"S, 5 m, 19 Mar 1997, *Van den Eynden & Cueva 946* (LOJA, QCA, QCNE). **Loja:** Lucarqui, ca. 79°50'48"W, 4°07'17"S, *Vivar & Merino 3430* (LOJA, QCA, QCNE); road Catacocha-Macará, km 42, 79°50'W, 4°08'S, 800 m, 2 Sep 2000, *Madsen & Sánchez 7169* (NY). **PERU. Tumbes:** Prov. Tumbes, Distr. Tumbes, Bosque Nacional de Tumbes, cerca de El Caucho o entre El Caucho y Pampas del Hospital, 8 Jan 1968, *Simpson & Schunke 600* (NY). **Piura:** Talara, 9 Apr 1929, *Haught 12* (NY); Dept. Paita, Sechura desert between Paita and Piura at turnoff on road to Sechura, ca. 100 m, 1 Jan 1964, *Hutchinson & Wright 3356* (UC, NY). **Lambayeque:** Dept. Lambayeque, near puente Chongoyape, ca. 2 km E of bridge, 450 m, 9 Feb 1988, *Gentry et al. 61379* (MO, NY); entre Hda. Patapo y Chongoyape, 200–300 m, 13 Aug 1952, *Ferreira 8384* (NY); Carretera entre Cayaltí y Oyotún, 150 m, 10 Oct 1986, *Díaz 2086* (MO, NY); 28 km of Olmos, 125 m, 9 Jun 1978, *Gentry et al. 22545* (NY). **Cajamarca:** Prov. Contumazá, 700 m, 29 Dec 1983, *Sagástegui & Mostacedo 11355* (NY). **La Libertad:** Prov. Trujillo, alrededores de Simbal, 550 m, 20 Jun 1986, *Mostacero et al. 1117* (F, MO, NY [2]); just N of Paiján along road between Trujillo and San Pedro Lloc, < 500 m, 2 Jan 1983, *Stevens 21985* (MO, NY). **Ica:** without locality, *Ruiz s.n.*, 1788 (B, MA [not seen], MO [ex herb. Pavón]).

Etymology.—The specific epithet refers to the resemblance of the leaf blades of this species with those of the genus *Avicennia* L. (Acanthaceae).

Chromosome number.—$n = 8$, $2n = 16$ [! Pazy, ! Przywara]. Ecuador: Guayas, ca. 2.5 km SE of Salinas, *H.H. Iltis & M. Iltis E-20* (WIS). Ecuador: Guayas, along highway 17 km W of Progreso *H.H. Iltis & M. Iltis E-1* (WIS).

Local names.—ECUADOR. Bichaya (Indigenous?, *Madsen 64140, 63826*); Vichayo (Indigenous?, *Van den Eynden & Cueva 946*). PERU. Guayabito de gentil, Guayabo de gentil (Spanish, *Mostacero et al. 1117*); Vichayo (Indigenous?, *Simpson & Schunke 600*).

Uses.—The fruits at maturity have a sweet pulp, reported as edible (*Svenson 11343, Núñez 127, Van den Eynden & Cueva 946*; Van den Eynden et al. 1999). However, there are also reports that the "leaves and fruits are toxic, produce dizziness and hallucinations" (*Woytkowski 7068*, MO, WIS, in Dpto. Lambayeque, Peru).

Phenology and Ecological interactions.—This species flowers during the day (Cornejo pers. obs.). This is an uncommon feature in neotropical Capparaceae, which in the coasts of Ecuador and Peru is also shared by the sympatric *Capparicordis crotonoides* (Kunth) Iltis & Cornejo. The small flowers with short stamens and gynophores of *Beautempsia avicenniifolia* are pollinated by bees (Madsen et al. 2001; *Madsen 63879*; Cornejo pers. obs.). The fruits are eaten and the seeds dispersed by the Sechura fox, *Lycalopex sechurae* Thomas (Huey 1969), a canid with similar distributional pattern to that of *Beautempsia avicenniifolia*.

Distribution.—Locally dominant along and close to the Pacific coast, from Cabo Pasado in Ecuador southward to Ica south of Lima, Peru, often found in the Ecuadorian coastal dry scrub forests, from sea level to 230 m (to 800 m in the very dry western Andean slopes of Loja), and in the Peruvian deserts, up to 700 m, often forming thickets and thus one of several dune stabilizers, apparently not salt tolerant.

This species has been misreported in Flora of Panama (Woodson et al. 1948) under the name of *Capparis ovalifolia*. However, *Beautempsia avicenniifolia* does not occur in that country. It is most likely that the single specimen cited for Panama (*Barclay s.n.*, "Isthmus of Darien") was collected on the coast of Ecuador (perhaps by Hinds?, see cited specimen), on the Voyage of H.M.S. Sulphur.

KEY TO THE AMERICAN GENERA OF CAPPARACEAE WITH VARIOUSLY STELLATE OR PELTATE INDUMENTA

1. Corolla with closed aestivation from buds, stamens not quickly acresscent just before anthesis.
  2. Calyx 1-seriate, bialate or spathaceous or 4-valvate with the sepals free or fused and the lobes regular, if irregular then the segments rupturing at or nearly to anthesis into 2 to 4 segments.
    3. Calyx at anthesis splitting to the base by 1 or 2 ruptures, finally bialate or spathaceous ________ **Belencita**
    3. Calyx at anthesis tubular, subcylindric or funnelform (*Steriphoma* Spreng.) or dish- or/to cup-shaped or hemispherical (the remaining genera), 2–4 sepals, lobes or segments.
      4. Calyx tubular, subcylindric or funnelform, usually bright orange to orange-red (alive), the apical lobes 2–4, indistinct at the early bud stage; stamens (5–)6(–8); fruits indehiscent, decomposing at maturity, linear, ± torulose, oblong or cylindric to thickly bacciform ________ **Steriphoma**
      4. Calyx dish- or/to cup-shaped or hemispherical, green, yellow or brown (alive), the 4 sepals or calyx lobes often distinct from early bud stage on, or totally fused but irregularly rupturing at anthesis into 2 to 4 segments (*Morisonia* L.); stamens (plus staminodes if any) 6 to 60; fruits globose, oblong to linear, if linear often torulose, capsular, pepos or amphisarca.
        5. Sepals entirely fused, irregularly rupturing at anthesis into 2–3(–4) segments; inflorescences cauliflorous and/or ramiflorous; fruits spherical amphisarca with gynophores very thick and several times shorter than fruit body ________ **Morisonia**
        5. Sepals or calyx lobes 4, distinct from bud or opening by linear sutures at or nearly to anthesis; inflorescences terminal; fruits globose, oblong to linear, if linear often torulose amphisarca, pseudoamphisarca, pepos or capsular, if amphisarca then with gynophores elongated.
          6. Sepals widely spaced, longitudinally arranged on and hiding the petal sutures, exposing the petals and not exceeded by the corolla in buds; corolla with valvate aestivation; cotyledons somewhat folded, 4–7 mm thick ________ **Calanthea**
          6. Sepals not widely spaced, entirely hidding the petals in young buds or if exposing the petals in buds, then never arranged on the petal sutures and greatly exceeded by the corolla (*Quadrella* [DC.] J. Presl, *Beautempsia*); corolla with torsivus or imbricate aestivation; cotyledons several times convolute, 0.7–1.5 mm thick.
            7. Leaves ovate to ovate-cordate, as wide or wider than long, with (sub) palmate venation at the base of the blade; flowers with yellow petals, 4 to 8 stamens, the nectary appendages 4, linear to linear-triangular, inserted on the inner edge of the calyx cup; fruits dehiscent, with the soft and very flexible fruit-wall splitting and falling apart in 2 to 4 segments at maturity ________ **Capparicordis**
            7. Leaves elliptic to obovate or oblong, two to several times longer than wide, with pinnate venation from leaf base; flowers with white to cream or greenish petals, 8 to 60 stamens, the nectary scales 4, triangular or/to deltoid, or 3- to 4-dentate or lobed nectary-dish or nectary-cup present, inserted within the hypanthium (*Colicodendron*, *Beautempsia*) or on a flat receptacle (*Quadrella*); fruits indehiscent or if dehiscent (*Quadrella*) then the fruit-wall coriaceous and remaining attached to the gynophore and placenta at maturity.
              8. Calyx dialisepalous, hypanthium absent; fruits capsular, usually linear-torulose to oblong ________ **Quadrella**

8. Calyx gamosepalous, the sepals fused at least at the base, hypanthium present; fruits amphisarca, pseudoamphisarca or pepos.
    9. Calyx ± cup-shaped, with closed aestivation, the sepals developed, their margins and tips touching each other from bud until near anthesis; nectary of a 4-dentate dish or cup or a 3-lobed cup; filaments of the stamens without basal nectaries, therefore the dish-shaped digitate pseudotorus is absent; inflorescences bearing showy flowers pollinated by vertebrates (bats); fruits large amphisarca or pseudoamphisarca ____ **Colicodendron**
    9. Calyx hemisphaerical-cyathiform, with open aestivation, the lobes very short to highly reduced, their margins not touching each other from bud; nectary of 4 scales, mostly free; staminal nectaries present at the base of the filaments forming a nectariferous dish-shaped digitate pseudotorus; inflorescences bearing small flowers pollinated by insects (bees); fruits small pepos ____ **Beautempsia**

2. Calyx 2-seriate, the sepals imbricate, partially exposing the inner pair of sepals in buds or the outer pair of sepals 2-valvate, entirely hidden the inner pair of sepals in buds until or nearly to anthesis.
    10. Leaf blades developed; style absent, stigma capitate; fruits amphisarca or (indehiscent) pepos, 4–20 × 4–8 cm, containing 10 to 30 larger seeds; indumenta stellate or/to candelabra throughout.
        11. Flower buds ellipsoid to oblong-elliptic and somewhat dorsal-ventrally compressed; flowers asymmetric, petals imbricate in bud, at anthesis adaxially and laterally arranged, and the stamens abaxially arranged; staminodia present; nectary of 3- to 4-dentate nectary cup present ____ **Sarcotoxicum**
        11. Flower buds spherical to ovate-globose, not compressed; flowers symmetric, petals siniestrorsely-torsivus (spirally twisted) in bud, petals and stamens radially arranged at anthesis; staminodia absent; nectary of 4 scales present.
            12. Shrubs to tall trees; inflorescences usually corymbose to racemes, floral bracts present, deciduous from young buds; sepals dimorphic, the outer pair valvate-connate or valvate-adnate, wider and entirely enclosing the narrower and more delicate inner pair of sepals until or nearly to anthesis; fruits amphisarca ____ **Neocalyptrocalyx**
            12. Lianas or scandent shrubs; flowers always solitary in leaf axis, ebracteate; sepals ± equal, imbricate in bud, the outer pair partially overlapping the inner pair, the inner pair exposed from very young bud; fruits pepos ____ **Mesocapparis**
    10. Leaf blades reduced; short style present, stigma bilobed, rather undifferentiated; fruits pseudopeponoid (tardily dehiscent), 4–6 × 4–6 mm, containing 1 to 2 small seeds; indumenta peltate throughout ____ **Atamisquea**

1. Corolla with open aestivation from buds, stamens usually quickly acrescent just before anthesis ____ **Gen. nov.**

ACKNOWLEDGMENTS

Thanks are due to the following herbaria for sending their collections as loan or gift for this study: AAU, B, BKL, CGE, DAV, F, GB, GH, GUAY, K, LA, LD, LE, MO, NY, OXF, P, QCA, QCNE, S, SEL, TEX, UC, US, WIS, Z. The authors thank an anonymous reviewer for providing a critical review of the manuscript, to John McNeill, Werner Greuter, John Wiersema and Gandhi Kanchi for their very helpful nomenclatural discussions, to Marie Long, Chris Pierce and Emma Antobam (NYBG Mertz library) for helping in different ways to obtain a scan of Gaudichaud's Plate 56 reproduced in figure 1 of this article, and to Barney Lipscomb for his efficient editorial work.

REFERENCES

Gaudichaud, Ch. 1866. Voyage autour du monde éxécuté pendant les années 1836 et 1837 sur la corvette La Bonite, commandée par M. Vaillant Capitaine de Vaisseau, Botanique. Paris, Arthus Bertrand.

Bentham, G. and J.D. Hooker. 1862. Capparideae. In: Genera Plantarum 1. London. Pp. 103–110.

Cornejo, X. and H.H. Iltis. 2008. Two new genera of Capparaceae: *Sarcotoxicum* and *Mesocapparis* stat. nov., and the reinstatement of *Neocalyptrocalyx*. Harvard Pap. Bot. 13:103–116.

Eichler, A.W. 1865. Capparideae. In C.F.P. von Martius, ed., Flora brasiliensis 13(1). München. Pp. 237–292.

Gaudichaud, Ch. 1842. Voyage autour du monde sur la corvette La Bonite, Atlas. Paris.

Huey, R.B. 1969. Winter diet of the Peruvian desert fox. Ecology 50:1089–1091.

HUTCHINSON, J. 1967. In: The genera of flowering plants (Angiospermae) Dicotyledones. Vol. 2. Clarendon Press, Oxford. Pp. 303–317

JOHNSTON, I.M. 1944. Publication dates of Gaudichaud's botany of the Voyage of The Bonite. J. Arnold Arbor. 25: 481–487.

KUNTH, C.S. 1821. Capparideae. In: von Humboldt, F.W.H.A., A.J.A. Bonpland, and C.S. Kunth. Nova genera et species plantarum [quarto ed.], 5. Paris. Pp. 82–98.

MADSEN, J., H. BASLEV, AND R. MIX. 2001. Flora of Puná Island: plant resources on a neotropical Island. Aarhus University Press.

MCNEILL, J., F.R. BARRIE, H.M. BURDET, V. DEMOULIN, D.L. HAWKSWORTH, K. MARHOLD, D.H. NICOLSON, J. PRADO, P.C. SILVA, J.E. SKOG, J.H. WIERSEMA, AND N.J. TURLAND. 2006. International code of botanical nomenclature (Vienna Code). Adopted by the 17th International Botanical Congress Vienna, Austria, July 2005. Gantner Verlag, Ruggell, Liechtenstein.

VAN DEN EYNDEN, V., E. CUEVA & O. CABRERA. 1999. Plantas silvestres comestibles del Sur del Ecuador – Wild edible plants of southern Ecuador. Ediciones Abya-Yala, Quito, Ecuador.

WOODSON, R.E. 1948. Capparidaceae. In: Woodson, R.E., R.W. Schery, and collaborators, eds. Flora of Panama, Part 5. Ann. Missouri Bot. Gard. 35: 75–99.

BOOK REVIEW

Jane Manaster. 2008. **Pecans: The Story in a Nutshell.** (ISBN 978-0-89672-640-6, pbk.). Texas Tech University Press, Box 41037, Lubbock, Texas 79409-1037, U.S.A. (**Orders:** www.ttup.ttu.edu, 1-800-832-4042). $19.95, 104 pp., 9 color photos, 9 b&w photos, 1 map, recipes, 5 1/2" × 9".

Pecans: The Story in a Nutshell is divided into eleven chapters that provide details on the history and natural range of the pecan tree in the U.S. as well as information on the cultivation, industry, and nutrition of "North America's favorite native nut." Manaster candidly writes about the origin of the pecan and explains how this native species has steadily increased its natural range through the years. Many early explorers documented the location and traditional uses of pecans. Throughout history many people have relied on this small nut to survive and have helped to create the many varieties of pecans that thrive in the southern United States today. Cultivation led to the formation of many large orchards, now a staple of our southern landscape. Many of the owners or workers developed new grafting techniques and standards for collecting ripe pecans.

Manaster even included a section with nearly two dozen recipes that provide the reader with instructions on how to create pralines, pecan logs, and candied or spiced pecans, pies, cakes and even soup. The author used historical images to specifically show the reader the history of this particular species. This book would be a good read for any naturalist or person that is eager to learn more about the life history of pecans in the U.S.—*Keri McNew, MS Biology, Programs Manager, Botanical Research Institute of Texas, Fort Worth, Texas 76102-4025, U.S.A.*

J. Bot. Res. Inst. Texas 3(2): 690. 2009

REVISIÓN DE LAS ESPECIES SUDAMERICANAS DEL GÉNERO *SCHWARTZIA* (MARCGRAVIACEAE: COMPLEJO *NORANTEA*)[1]

Diego Giraldo-Cañas
Instituto de Ciencias Naturales
Facultad de Ciencias
Universidad Nacional de Colombia
Apartado 7495, Bogotá, D.C., COLOMBIA
dagiraldoc@unal.edu.co

RESUMEN

Se presenta el estudio taxonómico para las especies sudamericanas del género *Schwartzia*. Se analizan diversos aspectos relativos a la clasificación, la nomenclatura y las afinidades genéricas. Se presentan las claves para reconocer los cinco géneros del complejo *Norantea* y las 14 especies de *Schwartzia* presentes en Sudamérica, así como las descripciones de las especies, sus sinónimos, distribución geográfica y se comentan algunas observaciones morfológicas y ecológicas. Se pudo establecer que Colombia es el país con el mayor número de especies de *Schwartzia* (seis especies, cuatro son endémicas), seguido de Brasil (cuatro especies, todas endémicas), Ecuador (tres especies, una de ellas endémica), Perú (dos especies, una endémica) y, Bolivia y Venezuela con una especie cada uno y ninguna endémica.

ABSTRACT

A taxonomic study of the South American species of the genus *Schwartzia* is presented. Aspects related to the classification, nomenclature, and generic affinities are discussed. Keys to the five genera of the *Norantea*-Complex and the 14 South American species of *Schwartzia* are given, as well as descriptions of the species, synonymy, geographical distribution, and morphological and ecological observations. Countries with the greatest number and diversity of *Schwartzia* species are Colombia with six species (four endemics), followed by Brazil (four species, all endemics), Ecuador (three species, one endemic), Peru (two species, one endemic), and Bolivia and Venezuela with one species each one.

La familia Marcgraviaceae es de distribución neotropical y consta de 110–130 especies (Cronquist 1981; Bedell 1989; Dressler 2001, 2004a, b), distribuidas en ocho géneros (Giraldo-Cañas 2007). Su distribución más septentrional la constituyen los estados de Chiapas, Oaxaca y Veracruz en México, mientras que la más austral corresponde a los estados de Paraná y Santa Catarina en Brasil. Sus representantes generalmente están restringidos a los bosques húmedos a pluviales de las regiones amazónica, andina, guayanesa, así como en el Chocó biogeográfico y Mesoamérica (principalmente Costa Rica y Panamá), aunque presenta un mayor endemismo hacia el noroeste de Sudamérica (Amazonia occidental y los Andes). Cabe destacar que de las 110–130 especies que se conocen para la familia, 56–60 están en Colombia, constituyendo el país con el mayor número de especies de Marcgraviaceae (Giraldo-Cañas 1999).

La familia Marcgraviaceae se caracteriza porque sus miembros corresponden a lianas epífitas o terrestres, o a arbustos epífitos y hemiepífitos, los cuales presentan dos tipos de nectarios, los que, según la terminología de Schmid (1988), reciben los nombres de nectarios extra-reproductivos laminales (glándulas presentes en la superficie abaxial de las hojas = "*hypophyllous glands*") y nectarios reproductivos (brácteas nectaríferas presentes en los pedicelos, en la base de éstos, en el raquis o en la base de la flor). Estos últimos corresponden a los nectarios nupciales extraflorales (sensu Schmid 1988 y Weberling 1992) y son los que más llaman la atención por su gran tamaño, posición, color y variedad de formas. Además, estos últimos son de gran importancia taxonómica en las Marcgraviaceae.

Las Marcgraviaceae no han sido estudiadas en su conjunto, aunque se cuenta con algunos tratamientos regionales y con la revisiones del complejo *Norantea* (Bedell 1985; no obstante esta tesis nunca fue publicada) y de los géneros *Ruyschia* Jacq. y *Souroubea* Aubl. (de Roon 1975). Es por esto que es fundamental empren-

---

[1] **Contribución derivada del proyecto "Estudios sistemáticos en el complejo *Norantea* Aubl. (Marcgraviaceae). Parte II", de la Dirección Académica-Investigación de la Universidad Nacional de Colombia, Bogotá, D.C.**

J. Bot. Res. Inst. Texas 3(2): 691 – 725. 2009

der estudios integrales de la familia a nivel continental más que regional. Por otra parte, se hace necesario esclarecer la taxonomía del complejo *Norantea*, al que pertenecen los géneros *Marcgraviastrum* (Wittm. ex Szyszyl.) de Roon & S. Dressler, *Norantea* Aubl., *Pseudosarcopera* Giraldo-Cañas, *Sarcopera* Bedell y *Schwartzia* Vell., ya que dicho complejo no es monofilético (Ward & Price 2002; Giraldo-Cañas 2007).

El género *Schwartzia* fue considerado por mucho tiempo parte de *Norantea* (Triana & Planchon 1862; Wittmack 1878; Szyszylowicz 1893; Gilg & Werdermann 1925; Macbride 1956; Reitz 1968; de Roon 1970, 1975; Punt 1971; Kummrow 1977; Ferreira 1982, 1995; Peixoto 1985; Pinheiro et al. 1995). Ambos géneros presentan inflorescencias racemosas, pero difieren básicamente en la longitud del pedicelo, el cual es largo en *Schwartzia* (1,4–9 cm) y corto en *Norantea* [0,3–0,7(–1,0) cm]. Por otra parte, en *Schwartzia* los nectarios reproductivos pedicelares son sésiles o cortamente pediculados (pedículo hasta de 7 mm de longitud) y se ubican generalmente en la porción media a proximal del pedicelo, mientras que en *Norantea* presentan un pedículo de 5–20 mm de longitud y nacen en el tercio proximal o en la porción media a distal del pedicelo. *Schwartzia* se distribuye desde Costa Rica y algunas islas del Caribe y Venezuela hasta Bolivia y el sur de Brasil, en donde crece en diferentes formaciones vegetales de áreas húmedas y maduras o con diferente grado de alteración (e.g., bosques de montaña, bosques nublados, manglares, campos rupestres, afloramientos rocosos, restingas, matas, matorrales, cerrados, yungas, riberas de ríos), entre el nivel del mar y los 2500 m de altitud.

En este trabajo se presenta la revisión de las especies sudamericanas del género *Schwartzia*, como continuación del estudio de las especies del complejo *Norantea* que viene adelantando el autor (véanse Giraldo-Cañas 2003, 2005, 2006, 2008, Giraldo-Cañas & Fiaschi 2005). El presente aporte pretende contribuir al estudio de la rica flora neotropical y en especial al conocimiento de la familia Marcgraviaceae.

MATERIALES Y MÉTODOS

Las técnicas utilizadas corresponden a las empleadas clásicamente en taxonomía y sistemática vegetales. Se consultaron las colecciones depositadas en los herbarios CEPEC, COAH, COL, CR, CUVC, CHOCO, F, HUA, IBGE, JAUM, MEDEL, MEXU, MO, MOL, MPU, NY, PSO, RSA, SI, SP, UDBC, UIS, US y VEN (abreviados de acuerdo con Holmgren et al. 1990). La terminología para las estructuras morfológicas está basada en Font Quer (1993), excepto en lo referente con la clasificación de los nectarios, siguiéndose en este caso a Schmid (1988) y para la terminología sexológica de las plantas se siguió a Cocucci (1980). Por otra parte, las palabras holotipo, isotipo, lectotipo, isolectotipo y otras similares, están escritas de acuerdo con Kiesling (2002: xi), autor que adopta y aconseja la forma sin acento ortográfico. Los datos concernientes al material tipo han sido tomados de varias fuentes bibliográficas, principalmente de Bedell (1985), así como de otras fuentes más recientes y de comunicación personal con curadores de diferentes herbarios (e.g., MEL, MOL, MPU).

RESULTADOS Y DISCUSIÓN

Delimitación actual de los cinco géneros del complejo *Norantea* (Tabla 1).

1. *Marcgraviastrum* está basado en *Norantea* subsect. *Marcgraviastrum* Wittm. ex Szyszyl. (= *Norantea* subgen. *Byrsophyllum* Delpino, = *Norantea* subgen. *Marcgraviastrum* Wittm.). Este género se distribuye desde Nicaragua hasta Bolivia y Brasil, y comprende 15 especies, las que se caracterizan por sus inflorescencias umbeladas a subumbeladas y donde cada pedicelo posee una flor fértil y un nectario reproductivo. En virtud de sus inflorescencias umbeladas, *Marcgraviastrum* es frecuentemente confundido con *Marcgravia*, pero éste último posee flores tetrámeras (cuatro sépalos, cuatro pétalos) vs. flores pentámeras en *Marcgraviastrum*, pétalos connatos constituyendo una caliptra caduca en *Marcgravia* vs. pétalos libres o sólo basalmente connatos en *Marcgraviastrum*; cada nectario reproductivo sin flor fértil (en la mayoría de los casos la flor aparece en forma rudimentaria en la porción distal del nectario) en *Marcgravia* vs. cada nectario reproductivo posee una flor fértil en *Marcgraviastrum*; además, *Marcgravia* presenta hojas dísticas, en tanto que en *Marcgraviastrum* son espiraladas.

2. *Norantea* es reconocido actualmente como un género monotípico y corresponde a *Norantea* subgen.

Tabla 1. Características de los cinco géneros del complejo *Norantea*.

Género	Tipo de Inflorescencia	Forma y posición del nectario reproductivo	Ovario y número de estambres	Distribución geográfica y número de especies
Marcgraviastrum	Umbelada a subumbelada	Tubular a sacciforme; en los pedicelos. Cada nectario reproductivo posee una flor fértil	Ovario 5–9-locular; estambres 10–75	Desde Nicaragua hasta Perú, Venezuela y Brasil. 15 especies
Norantea	Racemosa	Tubular, sacciforme, cilíndrico o clavado; en los pedicelos. Cada nectario reproductivo posee una flor fértil.	Ovario 5-locular; estambres 15–38	Sudamérica tropical. Una especie
Pseudosarcopera	Racemosa	Sacciforme a galeado; en el raquis, justo por debajo de la inserción del pedicelo al raquis. Cada nectario reproductivo posee una flor fértil.	Ovario 3 ó 4 locular; estambres 8–14	Colombia, Ecuador, Perú y Bolivia. Dos especies
Sarcopera	Espiciforme (flores sésiles)	Ciatiforme, cocleariforme, cupuliforme o sacciforme; en el raquis (en la base de la unión de la flor al raquis). Cada nectario reproductivo posee una flor fértil.	Ovario 2–3(–5)-locular; estambres 6–30	Desde Honduras hasta el norte de Bolivia, así como en Venezuela y Brasil. Ocho especies
Schwartzia	Racemosa	Sacciforme, tubular, cimbiforme, ciatiforme, cocleariforme, galeado, cuculado, urceolado o ventricoso; en los pedicelos. Cada nectario reproductivo Posee una flor fértil.	Ovario 3–5-locular; estambres 10–80 (sólo una especie presenta 5)	Desde Costa Rica hasta Bolivia y Brasil, así como en Venezuela y las Antillas Menores. 17 especies

Sacciophyllum Delpino [= *Norantea* sect. *Sacciophyllum* (Delpino) Gilg & Werderm.]. *Norantea* se caracteriza por su inflorescencia multiflora y largamente racemosa, por sus flores cortamente pediceladas y por sus grandes nectarios reproductivos de color rojo encendido, los cuales se ubican en el pedicelo. En Sudamérica se distribuye en Colombia, Venezuela, Guayana Francesa, Surinam, Guyana, Trinidad y Tobago, Ecuador, Perú, Bolivia y Brasil; al parecer, las pocas colecciones centroamericanas y jamaiquinas provienen de material cultivado. Su gradiente altitudinal está comprendido principalmente entre el nivel del mar y los 1000 m, aunque puede haber algunas poblaciones creciendo cerca de los 2000 m.

3. *Pseudosarcopera*. Este género es fácilmente reconocible en el complejo *Norantea*, ya que es el único que presenta inflorescencias racemosas y a la vez, nectarios reproductivos que siempre nacen en el raquis, mientras que en los demás géneros los nectarios reproductivos siempre nacen en el pedicelo cuando las inflorescencias son racemosas, en tanto que en *Sarcopera* – el género más cercano a *Pseudosarcopera* - si bien los nectarios reproductivos nacen en el raquis, sus inflorescencias siempre son espiciformes (flores sésiles). Hasta el momento, sólo se conocen dos especies para *Pseudosarcopera*: *Pseudosarcopera diaz-piedrahitae* (Giraldo-Cañas) Giraldo-Cañas, una especie endémica de la región del Chocó Biogeográfico de Colombia y Ecuador, y *Pseudosarcopera oxystylis* (Baill.) Giraldo-Cañas, endémica de la región andina oriental de Bolivia y Perú.

4. *Sarcopera* está basado en las especies anteriormente ubicadas en *Norantea* subgén. *Pseudostachyum* Delpino [= *Norantea* subsect. *Pseudostachyum* (Delpino) Szyszyl., = *Norantea* sect. *Pseudostachyum* (Delpino) Gilg & Werderm.]. Este género se distribuye desde Honduras hasta Bolivia y Brasil y posee ocho especies, las cuales se caracterizan por sus inflorescencias espiciformes (flores sésiles) y por sus nectarios reproductivos, los que se originan en el raquis justo por debajo de la inserción de las flores a éste.

5. *Schwartzia* consta de las especies previamente reconocidas en *Norantea* subgén. *Cochliophyllum* y de otras ubicadas en *Norantea* subgén. *Byrsophyllum*. Este género fue considerado por mucho tiempo parte de *Norantea*, a pesar de que había sido propuesto por Vellozo en 1825 (publicado en 1829). Ambos géneros presentan inflorescencias racemosas, pero difieren básicamente en la longitud del pedicelo, el cual es largo en *Schwartzia* (1,4–9 cm) y corto en *Norantea* [0,3–0,7(–1,0) cm]. Por otra parte, en *Schwartzia* los nectarios reproductivos son sésiles o cortamente pediculados (pedículo hasta de 7 mm de longitud) y se ubican generalmente en la porción media a proximal del pedicelo, mientras que en *Norantea* presentan un pedículo de 5–20 mm de longitud y nacen en el tercio proximal o en la porción media a distal del pedicelo. *Schwartzia* incluye 17 especies y se distribuye desde Costa Rica y algunas islas del Caribe hasta Colombia, Venezuela, Ecuador, Perú, Bolivia y el sur de Brasil, en donde crece en diferentes formaciones vegetales de áreas húmedas y maduras o con diferente grado de alteración, entre el nivel del mar y los 2500 m de altitud. De las 17 especies del género, 14 están en Sudamérica, siendo 13 especies exclusivas de este subcontinente y una [*S. spiciflora* (A.L. Juss.) Bedell] es compartida con las Antillas Menores (Dominica, Guadalupe, St. Vincent y Trinidad).

CLAVE PARA SEPARAR LOS CINCO GÉNEROS DEL COMPLEJO *NORANTEA*

1. Nectario reproductivo naciendo en el raquis justo por debajo de la unión del pedicelo o de la flor al raquis.
    2. Flores sésiles (inflorescencias espiciformes); nectario reproductivo ciatiforme, cocleariforme, cupuliforme o sacciforme; ovario 2–3(–5)-locular; estambres 6–30 **Sarcopera**
    2. Flores pediceladas (inflorescencias racemosas); nectario reproductivo sacciforme a galeado; ovario 3 ó 4 locular; estambres 8–14 **Pseudosarcopera**
1. Nectario reproductivo naciendo directamente en el pedicelo, nunca en el raquis.
    3. Inflorescencias umbeladas a subumbeladas; nectario reproductivo tubular a sacciforme; ovario 5–9-locular **Marcgraviastrum**
    3. Inflorescencias conspicuamente racemosas; nectario reproductivo tubular, sacciforme, cilíndrico, clavado, cimbiforme, ciatiforme, cocleariforme, cuculado, galeado, urceolado o ventricoso; ovario 3–5-locular.
        4. Flores largamente pediceladas, pedicelo de 1,4–9 cm de longitud; nectarios reproductivos localizados en la porción media a proximal del pedicelo, raramente en la porción distal pero nunca cercanos al cáliz, con un pedículo de 0–7 mm de longitud **Schwartzia**
        4. Flores cortamente pediceladas, pedicelo de 0,3–1 cm de longitud; nectarios reproductivos localizados en el tercio proximal o en la porción media a distal del pedicelo, con un pedículo de 5–20 mm de longitud **Norantea**

Schwartzia Vell., Fl. Flumin. 5:221. 1825 [1829]. Especie tipo: *Schwartzia glabra* Vell. [= *S. brasiliensis* (Choisy) Bedell ex Gir.-Cañas].

Arbustos escandentes, lianescentes, epífitos a hemiepífitos, raramente terrestres. Hojas enteras, espiraladas, cortamente pecioladas, raras veces conspicuamente pecioladas, coriáceas, glabras, con glándulas laminales en el envés, generalmente submarginales; venación secundaria débil, broquidódroma, en ocasiones suprimida en una o en ambas caras. Inflorescencia terminal, [excepto en la especie de Costa Rica *S. jimenezii* (Standl.) Bedell, en la que siempre es lateral], racemosa, pauciflora o más comúnmente multiflora, laxa o más frecuentemente densa; pedicelos conspicuamente alargados, de 1,4–9 cm de longitud, dispuestos en forma espiralada en el eje de la inflorescencia. Nectarios reproductivos sacciformes, tubulares, cimbiformes, ciatiformes, cocleariformes, galeados, cuculados, urceolados o ventricosos, uno por pedicelo, pedículos hasta de 7 mm de longitud, ubicados en la porción media a proximal del pedicelo o raramente cercanos al cáliz aunque no pegados al mismo; en ocasiones el pedicelo más proximal con una bráctea foliosa y el terminal sólo con el nectario sin llegar a desarrollar flor alguna. Flores largamente pediceladas, dispuestas en forma horizontal u oblicua en el pedicelo, perfectas, actinomorfas; bractéolas 2, alternas, subopuestas a opuestas, sepaloides, orbiculares, obtusas a emarginadas o deltoides, persistentes, sosteniendo el cáliz o alejadas de éste varios milímetros; sépalos 5, imbricados en dos series, suborbiculares a orbiculares, persistentes; pétalos 5, libres o connatos basalmente, reflexos en la antesis; estambres generalmente numerosos (más de 10, aunque muy raramente puede haber sólo 5), en uno o varios verticilos, filamentos lineares a aplanados, libres o basalmente connatos y/o adnatos a la base de los pétalos, anteras introrsas, basifijas a subbasifijas, subcordatas o subsagitadas; ovario súpero, globoso a cónico o piriforme; estigma mamiforme, lobulado o radiado, subsésil. Frutos capsulares, coriáceos, globosos, apiculados; semillas reniformes, falcadas, semilunares, elípticas u oblongas, reticuladas, negruzcas, brillantes, numerosas, raramente escasas.

Etimología.—Género dedicado al botánico sueco D. Schwartz (Vasconcellio Souza 1881).

Observaciones.—Con relación a la venación secundaria, Gentry (1993: 595) anotó que en todas las especies de *Schwartzia* ésta es suprimida, lo cual no coincide con mis observaciones, ya que en este género puede haber especies con venación secundaria débil o en ocasiones, suprimida en una o en ambas caras. Cabe destacar que en vista del gran tamaño de las estructuras florales de las especies del género *Schwartzia*, se elimina toda posibilidad de polinización entomófila, pues los insectos, incluso los más grandes, no podrían simultáneamente alimentarse del néctar y a la vez tocar los órganos reproductivos durante una visita (Pinheiro et al. 1995). Por lo tanto, los únicos polinizadores posibles serían vertebrados como algunas especies de pájaros, murciélagos u otros pequeños mamíferos (véanse Gentry 1991; Weberling 1992; Sazima et al. 1993, Pinheiro et al. 1995, Arruda et al. 2007). No obstante, las inflorescencias son visitadas por numerosas especies de abejas, avispas, hormigas y mariposas.

CLAVE PARA SEPARAR LAS ESPECIES SUDAMERICANAS DE *SCHWARTZIA*

1. Nectarios reproductivos cimbiformes, cuculados, cocleariformes, ciatiformes o ventricosos.

2. Nectarios reproductivos cuculados o cocleariformes. Plantas de Brasil **4. S. brasiliensis**

2. Nectarios reproductivos cimbiformes, ciatiformes o ventricosos.

3. Doce estambres por flor. Plantas de Ecuador **11. S. pterosara**

3. Veintidós o más estambres por flor. Plantas de Colombia o de las Antillas Menores y el norte de Venezuela (Estado Sucre).

4. 48 estambres por flor. Plantas de Colombia **10. S. parrae**

4. 22 estambres por flor. Plantas de las Antillas Menores y el norte de Venezuela (Estado Sucre) **13. S. spiciflora**

1. Nectarios reproductivos sacciformes, tubulares, globosos o galeados.

5. Bractéolas deltoides.

6. Sépalos de 2,8–3,6 mm de longitud; pétalos de 6–9 mm de longitud; bractéolas subopuestas a alternas, ubicadas a 1–4 mm del cáliz; 3–12 pares de glándulas laminales por hoja. Plantas de Brasil **1. S. adamantium**

6. Sépalos de 1,8–2 mm de longitud; pétalos de 4,7–5,2 mm de longitud; bractéolas opuestas, sosteniendo el cáliz; 2–7 pares de glándulas laminales por hoja. Plantas de Brasil **7. S. jucuensis**

5. Bractéolas orbiculares a suborbiculares, nunca deltoides.

7. Hojas con venación secundaria suprimida, ya bien sea en ambas caras o sólo en el envés.

8. Hojas con venación secundaria suprimida en ambas caras. Plantas de Brasil **6. S. geniculatiflora**

8. Hojas con venación secundaria suprimida sólo en el envés.

9. Boca de los nectarios reproductivos rostrada.

10. Estambres 20, adnatos a la base de los pétalos; pedúnculo de 4–6,5 cm de longitud; 4–9 pares de glándulas laminales por hoja. Plantas de Colombia **2. S. andina**

10. Estambres 13, libres; pedúnculo de 10–14 cm de longitud; 15–24 pares de glándulas laminales por hoja. Plantas de Perú **9. S. magnifica**

9. Boca de los nectarios reproductivos con las márgenes conspicuamente revolutas. Plantas de Bolivia y Perú **14. S. weddelliana**

7. Hojas con venación secundaria impresa en el envés.

11. Hojas obovadas; bractéolas emarginadas. Plantas de Colombia **3. S. antioquensis**

11. Hojas elípticas a oblongas; bractéolas orbiculares, obtusas.

12. Nectarios reproductivos pedicelares sacciformes, tubulares o globosos; urnas de los nectarios reproductivos pedicelares con la boca rostrada; estambres 25–50.

13. Sépalos de (4–)5–7 mm de longitud; bractéolas de 2,5–5 mm de longitud; estambres 50; ovario de 3–8 mm de longitud; fruto de 14–17 mm de diámetro; urnas de los nectarios reproductivos pedicelares de 15–33 mm de longitud con el pedículo de 1–2 mm de longitud; hojas subsésiles a cortamente pecioladas, pecíolo de 3–10 mm de longitud. Plantas de Colombia y Ecuador **5. S. chocoensis**

13. Sépalos de 2,2–2,8 mm de longitud; bractéolas ca. 2 mm de longitud; estambres ca. 25; ovario ca. 2,5 mm de longitud; fruto ca. 3 mm de diámetro; urnas de los nectarios reproductivos pedicelares de 9–17 mm de longitud con el pedículo ca. 1 mm de longitud; hojas conspicuamente pecioladas, pecíolo de 9–32 mm de longitud. Plantas de Colombia y

Ecuador ________ **8. S. lozaniana**

12. Nectarios reproductivos pedicelares galeados; urnas de losnectarios reproductivos pedicelares con la boca no rostrada; estambres 70. Plantas de Colombia ________ **12. S. renvoizei**

1. Schwartzia adamantium (Cambess.) Bedell ex Gir.-Cañas, Hickenia 3(32):121. 2002. (**Fig. 1**). *Norantea adamantium* Cambess., Fl. Bras. Mer. [quarto ed.] 1:312, t. 62. 1828. *Ascium adamantium* Steud., Nomencl. bot. ed. 2, 1:145. 1840, nom. superfl. TIPO: BRASIL: In parte provinciae Minas Gerais dicta Distrito dos Diamantes, *St. Hilaire s.n.* [HOLOTIPO: MPU; ISOTIPOS: F!, P, véase Bedell (1985: 143)].

Arbustos escandentes, muy ramificados, ramas postradas o decumbentes, hasta de 4(–7) m de altura, terrestres o rupícolas; tallos cilíndricos a subteretes, corteza castaño, estriada longitudinalmente. Hojas sésiles a subsésiles o cortamente pecioladas, cuando pecioladas entonces el pecíolo engrosado, recurvado, canaliculado, levemente estriado, castaño oscuro, hasta de 3 mm de longitud; láminas ovadas a obovadas, de 3,5–10,5 cm de longitud × 2–7,5 cm de ancho, de base redondeada a cuneada y ápice obtuso y/o diminutamente emarginado, con márgenes planas o levemente revolutas; nervio medio conspicuo en ambas caras, desvaneciéndose hacia su porción distal, plano en la haz y ligeramente elevado en el envés, liso; venación secundaria débil en ambas caras; 3–8(–12) pares de glándulas laminales en la superficie abaxial, dispuestas en una fila más o menos regular a ambos lados de la cara abaxial, distanciadas 5–11 mm de la margen, elípticas, conspicuamente distanciadas entre sí, ca. 1 mm de largo × 0,5 mm de ancho, con su orificio elíptico, negruzco. Inflorescencia terminal, racemosa, multiflora, levemente laxa a más comúnmente densa; pedúnculo de 4–14 cm de longitud; pedicelos de 3,5–8 cm de longitud, levemente curvos a más frecuentemente rectos, oblicuos con relación al eje de la inflorescencia, lisos a ligeramente estriados, castaño oscuros. Nectarios reproductivos pedicelares sacciformes a tubulares, péndulos, pedículos de los nectarios de 1–6 mm de longitud, urnas de 5–18 mm de longitud × 3–7 mm de ancho, con la boca circular dispuesta hacia el eje de la inflorescencia y con las márgenes revolutas y generalmente rostrada; los nectarios naciendo en el cuarto o quinto proximal del pedicelo. Flores 18–70; bractéolas sepaloides, subopuestas a alternas, deltoides, carnosas, de 2 mm de longitud, ubicadas a 1–4 mm del cáliz; sépalos orbiculares, carnosos, de 2,8–3,6 mm de longitud; pétalos libres, oblongos a ovados, carnosos, de 6–9 mm de longitud × 4–5 mm de ancho; estambres ca. 20, filamentos ca. 3 mm de longitud, aplanados, anchos en la base y angostos en su ápice, lisos, libres, anteras oblongas, subsagitadas, amarillentas, ca. 2,5 mm de longitud × ca. 0,7 mm de ancho; ovario cónico, de 4–5 mm de longitud; estilo cónico, ca. 1 mm de longitud; estigma mamiforme, negruzco. Frutos globosos, apiculados, ligeramente rugosos, de 12–14 mm de diámetro; semillas oblongas a reniformes, de 2,5–3 mm de longitud, rugosas, reticuladas, negruzcas, brillantes, numerosas.

Distribución geográfica y ecología.—*Schwartzia adamantium* es endémica de las regiones oriental y centro-oeste de Brasil; se tienen registros de los estados de Bahia, Goiás, Minas Gerais y el Distrito Federal. Esta especie crece en cerrados, campos rupestres, afloramientos rocosos, serranías, matorrales de suelos arenosos y en áreas boscosas, entre los 500 y los 1500 m.

Observaciones.—*Schwartzia adamantium* puede ser confundida con la especie simpátrica *S. brasiliensis*. Sin embargo, éstas pueden diferenciarse fácilmente por los nectarios reproductivos pedicelares sacciforme-tubulares en *S. adamantium* vs. cuculados a cocleariformes en *S. brasiliensis*, por la longitud de los pecíolos (0–3 mm en *S. adamantium* vs. 5–15 mm en *S. brasiliensis*), por la longitud de los pedicelos (3,5–8 cm en *S. adamantium* vs. 1,5–4 cm en *S. brasiliensis*), por la forma de las bractéolas (deltoides en *S. adamantium* vs. ovadas a oblanceolas en *S. brasiliensis*), por la longitud de los sépalos (2,8–3,6 mm en *S. adamantium* vs. 1,5–2,1 mm en *S. brasiliensis*), por la longitud de los pétalos (6–9 mm en *S. adamantium* vs. 5–6 mm en *S. brasiliensis*) y por el tamaño de las semillas (2,5–3 mm de longitud en *S. adamantium* vs. 5–6 mm en *S. brasiliensis*).

Especímenes examinados: **BRASIL. Bahia:** Mun. Rio de Contas, Pico das Almas, vertente este, 13–14 km ao NO da cidade, 1180–1200 m, 28 oct 1988, *R. Harley et al. 25726* (NY). Mun. Agua Quente, pico das Almas, vertente norte, vale ao noroeste do Pico, 1400 m, 1 dic 1988, *R. Harley et al. 26538* (NY). Mun. Agua Quente, pico das Almas, vertente oeste, trilho do povoado da Santa Rosa, 23 km ao O da cidade, 1200 m, 1 dic 1988, *R. Harley & N. Taylor 27042* (NY); valley of the Rio das Ondas, Cerrado on slopes of the Espigão Mestre, ca. 8 km NW of Barreiras, road to Santa Rita da Cássia, 600 m, 3 mar 1971, *H. Irwin et al. 31442* (NY). **Distrito Federal:** Brasília D.F.,

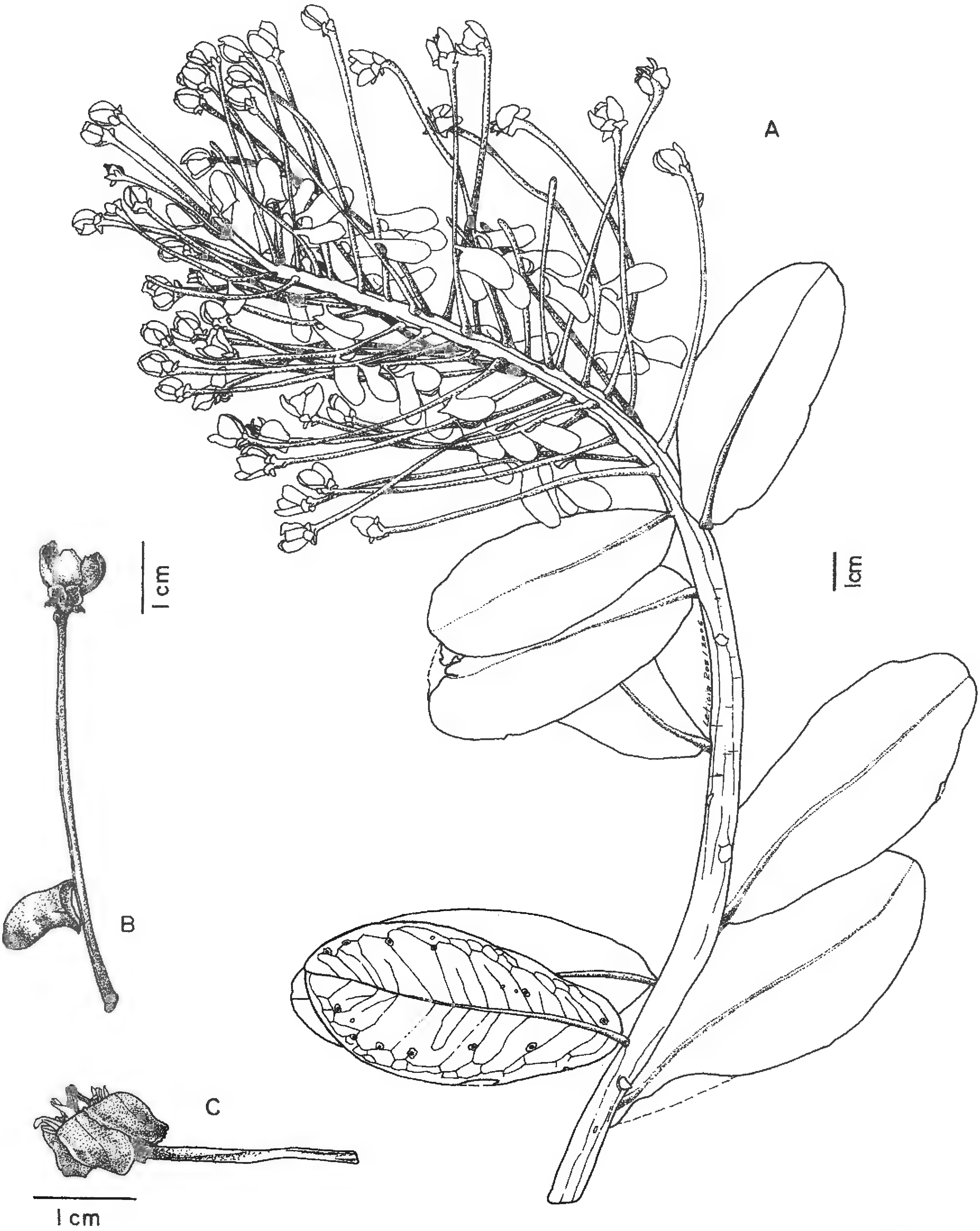


Fig. 1. *Schwartzia adamantium* (Cambess.) Bedell ex Gir.-Cañas. A. Rama florífera. B. Botón floral y nectario reproductivo pedicelar. C. Flor en antesis. (*H. Irwin et al. 9718*).

Córrego Pipiripau, afluente do Rio São Bartolomeu, 8 ago 1980, *E. Heringer et al. 5402* (US). **Goiás:** Serra dos Cristais, 5 km by road E of Cristalina, 1200 m, 5 abr 1973, *W. Anderson 8209* (NY); Chapada dos Veadeiros, 23 km de Alto Paraiso em direção a Teresina de Goiás, Parque Nacional da Chapada dos Veadeiros, Cruzeiro, 1410 m, 12 nov 1996, *M. Aparecida da Silva & A. dos Santos 3201* (IBGE); Parque Nacional da Chapada dos Veadeiros, estrada para Colinas a 34 km do entroncamento da Go, Alto Paraíso de Goiás, 15 ago 1990, *T. Barbosa Cavalcanti et al. 665* (SP); Alto Paraíso de Goiás, Parque Nacional da Chapada dos Veadeiros, no caminho para a Cachoeira do Rio Preto, 20 nov 1987, *I. Cordeiro et al. 434* (COL). Mun. Alto Paraiso, Fazenda Santo Antônio, 6 jul 1996, *J. Felfili et al. 354* (IBGE); Cristalina, 12 jul 1988, *T. Filgueiras & D. Alvarenga 1427* (IBGE); Parque Nacional Chapada dos Veadeiros, Alto Paraiso-Cruzeiro, 1126 m, 28 sep 1995, *M. Fonseca et al. 657* (IBGE), 6 dic 1988, *M. Pereira Neto 106* (IBGE); Serra de Biribiry, 7–10 km W of Diamantina, 1200 m, 15 jul 1965, *S. Glassman & J. Gomes Jr. 8154* (F, SP); Estrada Alto Paraiso-Teresina, 10 oct 1979, *E. Heringer et al. 2357* (IBGE, NY); Alto da Serra de Jaraguá, 30 sep 1974, *E. Heringer 14026* (IBGE); Chapada dos Veadeiros, ca. 12 km NW of Veadeiros, 1200 m, 19 oct. 1965, *H. Irwin et al. 9310* (NY). Mun. Cristalina, Serra dos Cristais, 5 km S of Cristalina, 1175 m, 1 nov 1965, *H. Irwin et al. 9718* (NY); Serra dos Cristais, 3 km N of Cristalina, 1250 m, 3 mar 1966, *H. Irwin et al. 13353* (NY); Serra dos Pireneus, pico dos Pirineus, ca. 20 km NW of Corumbá de Goiás, near road to Niquelândia, ca. 1400 m, 28 ene 1968, *H. Irwin et al. 19355-A* (NY); Serra dos Pireneus, ca. 20 km E of Pirenópolis, 1000 m, 14 ene 1972, *H. Irwin et al. 34058* (MO, NY). Mun. Pirenópolis, Serra dos Pirineus, 18 oct 1956, *L.B. S. & A.M. 4803* "Herbario A. Macedo" (US-2248310) (esta misma colección aparece en el herbario SP como *A. Macedo & L.B. Smith 4803*); 21 jul 1955, *A. Macedo 3853* (MO). Mun. Posse, km 16 da estrada Posse-Guarani de Goiás, via serra, 10 ago 1994, *B. Pereira & D. Alvarenga 2632* (COL, IBGE); Cristalina, ca. 8 km da cidade, estrada para Paracatu, 1050 m, 4 feb 1987, *J. Pirani et al. 1586* (SP); Pirineus, sin fecha, *Rizzo 5890* (NY), 4 sep 1971, *Rizzo 6713* (NY); Cristalina, 1250 m, 15 oct 1960, *Colector (?, letra ilegible) 7767* (NY). **Minas Gerais:** Serra do Espinhaço, ca. 18 km by road SW of Diamantina on road to Curvelo, 1400 m, 10 abr 1973, *W. Anderson 8517* (NY); Serra do Espinhaço, 9 km by road SW of Mendanha and the Rio Jequití on road to Diamantina, 1150 m, 14 abr 1973, *W. Anderson 8890* (NY); 20 km S de Diamantina, serra na estrada para Conselheiro da Mata, 17 may 1977, *P. Gibbs et al. 5268* (NY). Mun. Diamantina, Estrada para Mendanha, a 15 km de Diamantina, 1200–1225 m, 31 oct 1988, *R. Harley et al. 25479* (NY); Córrego do Tigre, Mun. Gouveia, campo rupestre, 14 sep 1985, *G. Hatschbach & F. Zelma 49657* (MO); Entre Brasília e João Pinheiro, 30 ago 1979, *E. Heringer & C. Rizzini 17432* (IBGE, MO, NY, US); 25 km W of Diamantina on road to Conselheiro Mata, 18 ene 1959, *H. Irwin 2482* (NY, US); Serra do Espinhaço at Lapinha, ca. 18 km N of Sêrro on road (MG 2) to Diamantina, 1200 m, 24 feb 1968, *H. Irwin et al. 20754* (NY); Serra do Espinhaço, ca. 15 km NE of Diamantina, on road to Mendanha, 1300 m, 26 ene 1969, *H. Irwin et al. 22582* (NY); Serra do Espinhaço, ca. 16 km W of Grão Mogol, 950 m, 17 feb 1969, *H. Irwin et al. 23452-A* (NY). Mun. Gouveia, campo rupestre, 1100 m, 3 jun 1985, *H. Leitão et al. 17194* (IBGE) ; 49 miles from Diamantina, ca. 1200 m, 22 dic 1959, *B. Maguire et al. 44739* (NY); on sandstone just west of Serra, road from Concenção to Diamantina, 9 ago 1960, *B. Maguire et al. 49129* (NY), *49138* (NY). Mun. Diamantina, 19 dic 1979, *G. Marninelli 6272* (MO); Diamantina, Estrada para Conselheiro da Mata, km 174, 4 feb 1987, *S. Mayo et al. s.n.* (NY); Grão-Mogol, Trilha da Tropa, no atto da serra, ca. 1000–1200 m, 11 dic 1989, *P. Sano et al. 12433* (MO).

2. Schwartzia andina Gir.-Cañas, Caldasia 25:5. 2003. (**Fig. 2**). Tipo: COLOMBIA. Antioquia: Mun. Valdivia, vereda San Fermín, Alto de Ventanas, 145 km al NE de Medellín, finca La Soledad, 2000 m, 7 ene 1994, *R. Callejas & A. Bornstein 11073* (holotipo: HUA!; isotipos: COL!, MO!).

Arbustos escandentes, epífitos a hemiepífitos; tallos cilíndricos, angulosos en las porciones distales de las ramas, levemente estriados a lisos, corteza castaño claro a negruzca. Hojas cortamente pecioladas; pecíolo recurvado, negruzco, de 3–7 mm de longitud × ca. 3 mm de ancho; láminas oblanceoladas a oblongas, de (8–)11,5–19 cm de longitud × (2,8–)4–6,5 cm de ancho, de base cuneada y ápice ligeramente apiculado, márgenes ligeramente revolutas; nervio medio conspicuo en ambas caras, plano a levemente hundido en la haz y ligeramente abultado en el envés, liso, ca. 3 mm de ancho en su porción basal, desvaneciéndose gradualmente hacia la región distal de la lámina; venación secundaria apenas perceptible en la haz (raras veces suprimida), siempre suprimida en el envés; 4–9 pares de glándulas laminales en el envés, localizadas a 5–10 mm de la margen, distanciadas entre sí 0,8–3,5 cm, elípticas, 1–1,8 mm de largo × ca. 0,4 mm de ancho, con su orificio elíptico, negruzco, de 0,8–1,4 mm de largo × ca. 0,25 mm de ancho. Inflorescencia terminal, cortamente racemosa, multiflora, densa; pedúnculo de 4–6,5 cm de longitud; pedicelos de 5–6,5 cm de longitud, cilíndricos, rectos, ensanchándose en su porción distal, lisos a levemente estriados o con pocas y sobreelevadas verrugosidades sólo en su extremo distal, cobrizos a castaño oscuros. Nectarios reproductivos pedicelares sacciformes, tubulares, péndulos, verde claros a purpúreos, reticulados, pedículos de los nectarios 1–2,3 mm de longitud, urnas de (7–)10–12(–14) mm de longitud × (3,3–)4–5(–6) mm de ancho, boca rostrada, con el orificio elíptico a circular, de 1,7–2,8 mm de ancho, dispuesta hacia el eje de la inflorescencia y ocupando una posición transversal respecto a su eje, los nectarios insertos por debajo del 1/3 proximal del pedicelo. Flores 16–26, inserción pedicelo-flor horizontal a levemente oblicua; bractéolas sepaloides, opuestas, orbiculares, obtusas, rugosas, carnosas, de (4–)4,8–5,3(–5,5) mm de longitud; sépalos orbiculares, rugosos, carnosos, de 5,3–6,6 mm de longitud, con las márgenes delgadas y translúcidas; pétalos connatos basalmente ca. 2/5 de su longitud, ovados, reflexos en la antesis, de 9–11 mm de longitud × ca. 4 mm de ancho, carnosos, verde claros; estambres 20, filamentos ca. 4 mm de longitud × ca. 0,6 mm de ancho,

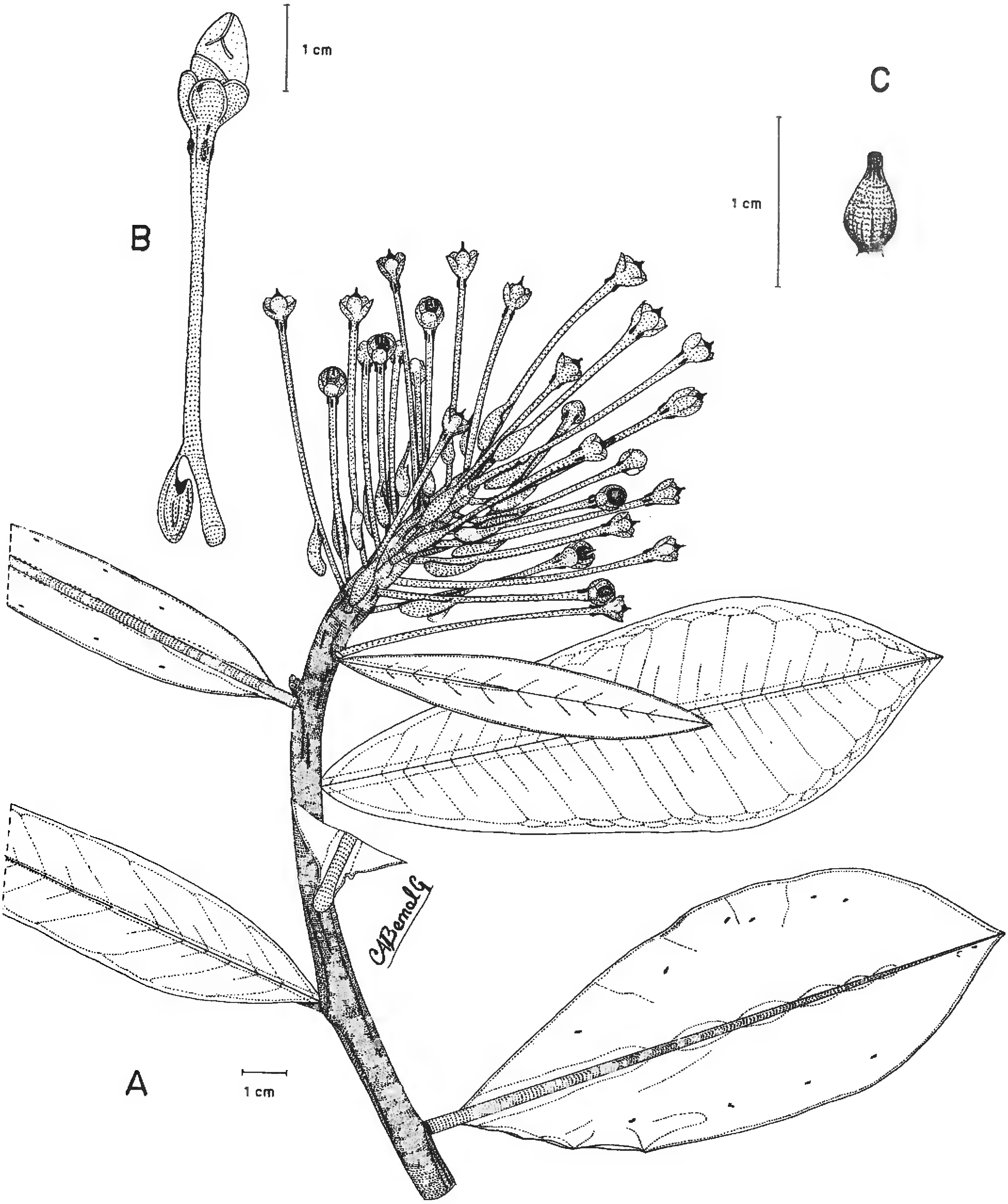


Fig. 2. *Schwartzia andina* Gir.-Cañas. **A.** Rama florífera. **B.** Botón floral y nectario reproductivo pedicelar. **C.** Ovario. (*R. Callejas 11073*).

aplanados, lisos, adnatos a la base de los pétalos, anteras oblongas, subbasifijas, ca. 3 mm de longitud × ca. 1 mm de ancho; ovario globoso a cónico, rugoso, de 5–6,5 mm de longitud × 3,5–5 mm de ancho; estigma mamiforme, subsésil, negruzco. Frutos desconocidos.

Distribución geográfica y ecología.—*Schwartzia andina* crece en bosques premontanos a montanos bajos, húmedos a pluviales y en bosques de niebla, entre los 1700 y los 2400 m. Esta especie sólo ha sido registrada en la región andina colombiana, en los departamentos de Antioquia, Caldas y Cauca. De esta especie sólo se conocen unas cuantas colecciones, las cuales proceden de áreas que están siendo deforestadas y/o transformadas drásticamente por el hombre, lo que podría significar que la especie se encuentra en peligro de extinción.

Observaciones.—*Schwartzia andina* siempre presenta el envés foliar con la venación secundaria suprimida. Por otra parte, presenta unas verrugas abultadas en la porción distal de los pedicelos.

Especímenes examinados: **COLOMBIA. Antioquia:** Mun. Briceño, vereda San Fermín, vía Ventanas-Briceño, km 2.5, 2100–2300 m, 11 nov 1987, *R. Callejas et al. 5569* (HUA, NY). Mun. Urrao, corregimiento La Encarnación, camino hacia el Parque Nacional Natural Las Orquídeas, primera loma, 2200–2400 m, 8 feb 1995, *J. Pipoly et al. 18621* (MO). **Caldas:** Manzanares-Pensilvania, 1750 m, 5 oct 1990, *W. Vargas & M. de Fraume 264* (HUA). **Cauca:** Mun. El Tambo, corregimiento 20 de Julio, carretera abandonada, cerca de 2 km de la cabaña del INDERENA, carretera que conducía al corregimiento Tuntas, límite con el Parque Nacional Natural Munchique, 2200 m, 6 ene 1991, *R. Ruiz et al. 1201* (MO).

3. Schwartzia antioquensis Gir.-Cañas, Caldasia 25:7. 2003. (**Fig. 3**). TIPO: COLOMBIA. ANTIOQUIA: Mun. Urrao, vereda Calles, río Calles, Parque Nacional Natural Las Orquídeas, 1400–1500 m, 4 may 1995, *R. Fonnegra & Grupo de Palinología 5569* (HOLOTIPO: COL!; ISOTIPOS: COL!, HUA!, MO!).

Arbustos lianescentes, profusamente ramificados, hemiepífitos, ramas robustas; tallos cilíndricos, levemente angulosos en las porciones distales de las ramas, huecos, corteza fuertemente estriada y rugosa, las estrías tranversales. Hojas pecioladas, pecíolo recurvado, canaliculado (el canal muy angosto y poco profundo), levemente estriado, castaño oscuro, de (8–)10–13(–16) mm de longitud × 3–6 mm de ancho; láminas obovadas, de 9–14,5 cm de longitud × 4,5–7(–8) cm de ancho, de base redondeada y ápice levemente mucronado, con márgenes ligeramente revolutas; nervio medio conspicuo, liso o levemente estriado y abultado en el envés, apenas perceptible y plano por la haz, desvaneciéndose hacia la porción distal de la lámina, ca. 2 mm de ancho en su porción proximal; venación secundaria levemente impresa en la haz, un poco más fuerte en el envés; 6–12 pares de glándulas laminales en la superficie abaxial, submarginales, localizadas a 1–3 mm de la margen, distanciadas entre si 0,7–3 cm, circulares, ca. 1 mm de diámetro, con su orificio circular a elipsoide, negruzco, ca. 0,5 mm de diámetro. Inflorescencia terminal, racemosa, multiflora, densa; pedúnculo de (5,5–)8–12(–14) cm de longitud; pedicelos de 6–8,5 cm de longitud, cilíndricos a levemente angulosos, lisos a estriados, ocasionalmente verrugosos, ensanchándose en su porción distal. Nectarios reproductivos pedicelares sacciformes, tubulares, péndulos, verdes a rojizos, rugosos, carnosos, pedículos de los nectarios de 1–3 mm de longitud, urnas de 24–32 mm de longitud × 8–11 mm de ancho, boca circular de 4–5 mm de diámetro, dispuesta hacia el eje de la inflorescencia y ocupando una posición oblicua respecto a su eje, los nectarios insertos por debajo del 1/3–1/4 proximal del pedicelo. Flores 18–24, inserción pedicelo-flor horizontal; bractéolas sepaloides, opuestas, orbiculares, emarginadas, carnosas, rugosas, de (3–)4–5,5 mm de longitud, con las márgenes delgadas y translúcidas; sépalos orbiculares, rugosos, carnosos, con las márgenes delgadas y translúcidas, de (6,5–)8–10(–11) mm de longitud; pétalos connatos basalmente ca. 2/5 de su longitud, ovados, carnosos, reflexos en la antesis, de 7–9 mm de longitud × ca. 4 mm de ancho; estambres ca. 22, filamentos ca. 2 mm de longitud × ca. 0,7 mm de ancho, aplanados, lisos, adnatos a la base de los pétalos, anteras subcordatas, oblongas, blanquecinas, ca. 2,5 mm de longitud × ca. 1 mm de ancho; ovario globoso a piriforme, rugoso, verde claro a amarillento, de 7–12 mm de longitud × 11–13 mm de ancho; estigma mamiforme, subsésil. Frutos globosos, carnosos, apiculados, rugosos, rojos cuando maduros, de 18–25 mm de diámetro; semillas elípticas, ca. 4,5 mm de longitud × ca. 2 mm de ancho, reticuladas, negruzcas, brillantes, numerosas.

Distribución geográfica y ecología.—*Schwartzia antioquensis* crece en bosques húmedos a pluviales y en bosques de niebla de áreas premontanas, entre los 1200 y los 1700 m. Esta especie sólo se conoce de unas cuantas colecciones de la región de Murrí en el municipio de Frontino y de la vereda Calles del Parque Nacional Natural Las Orquídeas (Antioquia, Colombia).

Observaciones.—En vista de su hábito robusto, *S. antioquensis* es fácilmente confundida con *S. chocoensis*. No obstante, estas especies pueden separarse fácilmente por la forma de las bractéolas (emarginadas en *S. antioquensis* vs. obtusas en *S. chocoensis*), el número de estambres (ca. 22 en *S. antioquensis* vs. ca. 50 en *S. chocoensis*), el tamaño del ovario (7–12 mm en *S. antioquensis* vs. 3–8 mm en *S. chocoensis*), la boca de los

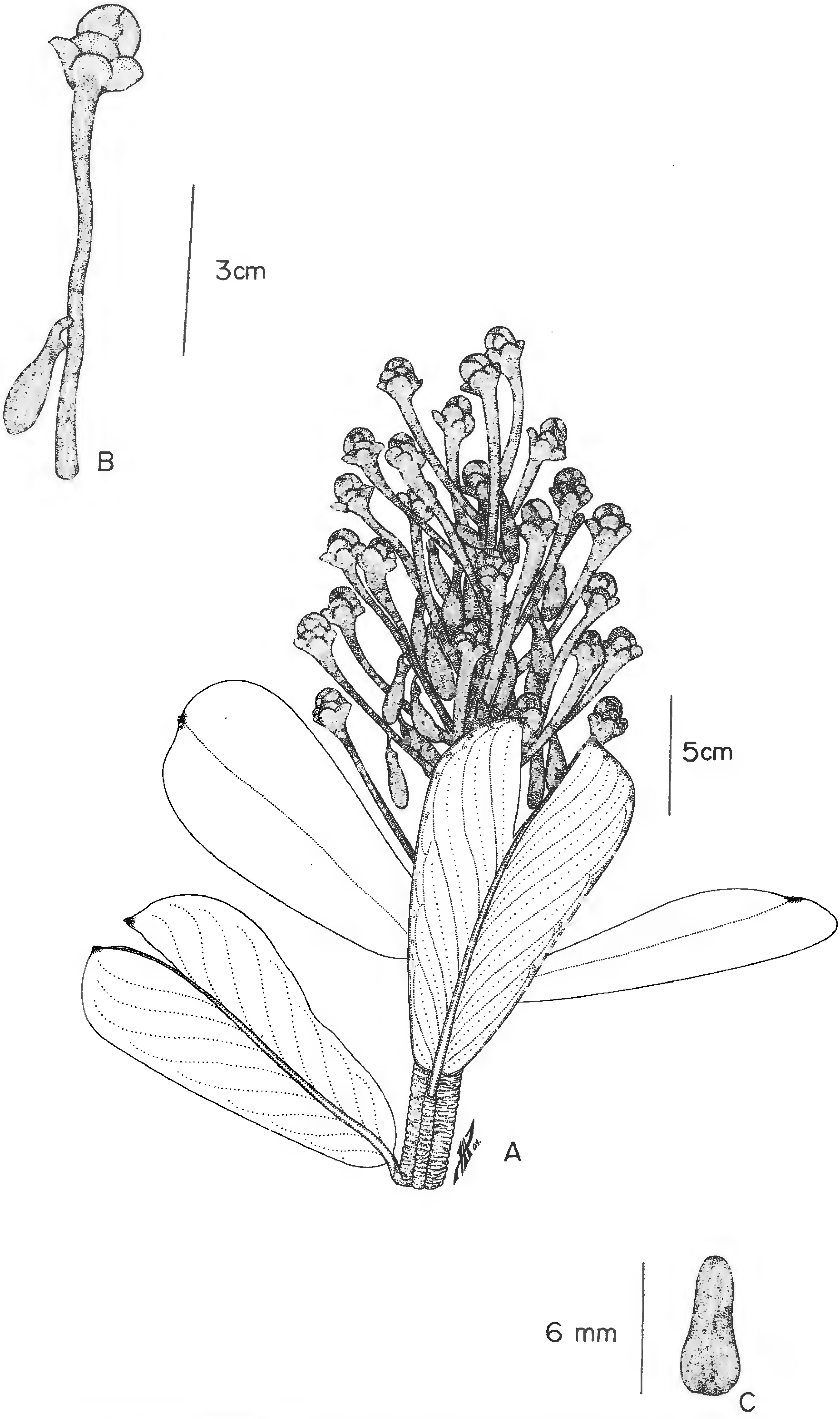


Fig. 3. *Schwartzia antioquensis* Gir.-Cañas. **A.** Rama florífera. **B.** Botón floral y nectario reproductivo pedicelar. **C.** Ovario. (*R. Fonnegra et al. 5569*).

nectarios reproductivos pedicelares (no rostrada en *S. antioquensis* vs. rostrada en *S. chocoensis*) y las dimensiones del fruto (18–25 mm en *S. antioquensis* vs. 14–17 mm en *S. chocoensis*). Véanse las observaciones dadas para *S. renvoizei*.

Especímenes examinados: **COLOMBIA. Antioquia:** Mun. Frontino, road to Murrí, 22.2 km W of Nutibara along road to Murrí, 1330 m, 19 oct 1987, *A. Brant & G. Martínez 1413* (HUA, MO). Mun. Frontino, corregimiento Nutibara, cuenca alta del río Cuevas, 1560 m, 10 jul 1986, *D. Sánchez et al. 282* (COL, MEDEL, MO, NY). Mun. Frontino, km 22 of road Nutibara-Murrí, 1290 m, 21 sep 1987, *J. Zarucchi et al. 5512* (COL, CHOCO, MO, NY). Mun. Frontino, km 18 of road Nutibara-La Blanquita, región de Murrí, 1620 m, 4 nov 1988, *J. Zarucchi et al. 7117* (COL, HUA, MO). Mun. Urrao, Parque Nacional Natural Las Orquídeas, sector Cabaña de Calles, quebrada La Agudelo, 1300–1400 m, 31 mar 1992, *D. Cárdenas et al. 3171* (MO). Mun. Urrao, vereda Calles, Parque Nacional Natural Las Orquídeas, margen derecha del río Calles, NW de la Cabaña de Calles, 1450 m, 6 dic 1993, *A. Cogollo et al. 7891* (MO). Mun. Urrao, Las Orquídeas, vereda Calles, río Calles, Parque Nacional Natural Las Orquídeas, quebrada Honda, al NW de la cabaña Calles, 1340 m, 7 dic 1992, *J. Pipoly et al. 16715* (MO), 1 dic 1993, *J. Pipoly et al. 17484* (MO), 9 dic 1993, *J. Pipoly et al. 18034* (MO).

4. Schwartzia brasiliensis (Choisy) Bedell ex Gir.-Cañas, Caldasia 23:341. 2001. (**Fig. 4**). *Norantea brasiliensis* Choisy in DC., Prodr. 1:566. 1824. Tipo: BRASIL: Rio de Janeiro, año 1814, *Langsdorff s.n.* (holotipo: P, isotipo: F!, fotografía del holotipo en F! y MO!).

Schwartzia glabra Vell., Fl. Flumin. 5:221. 1825 [1829]. Tipo: BRASIL: *Vellozo s.n.* [holotipo: no localizado, probablemente en MEL, véase Bedell (1985: 142)].

Ascium selloi Spreng., Syst. Veg. 2:599. 1825. *Norantea selloi* (Spreng.) G. Don, Gen. Hist. 2:599. 1825. Tipo: BRASIL: *Sello 178* [holotipo: W, véase Bedell (1985: 134)].

Arbustos escandentes, epífitos a más comúnmente terrestres, profusamente ramificados, ramas decumbentes hasta de 8 m de altura, tallos subteretes, lisos a levemente estriados longitudinalmente, corteza castaño a ferrugínea. Hojas pecioladas; pecíolo recurvado, canaliculado, ligeramente estriado, castaño oscuro, de 5–14(–15) mm de longitud × ca. 2 mm de ancho; láminas ovales, obovadas a oblanceoladas, de 5–16 cm de longitud × 3–6 cm de ancho, de base redondeada a cuneada y ápice obtuso, emarginado, retuso o mucronado, con márgenes planas o ligeramente revolutas y engrosadas; nervio medio conspicuo en ambas caras, desvaneciéndose hacia su porción distal, plano o levemente hundido en la haz y abultado en el envés, liso a estriado longitudinalmente; venación secundaria débilmente impresa en ambas caras; 3–20 pares de gándulas laminales en la superficie abaxial, elipsoides, de 0,5–1 mm de longitud × 0,25–0,5 mm de ancho, unas submarginales, a 1–2 mm de la margen, otras distanciadas a 5–16 mm de la margen y dispuestas en filas más o menos uniformes a ambos lados del envés, aunque también puede haber glándulas laminales distribuidas en forma irregular y próximas a la parte media del envés. Inflorescencia terminal, racemosa, multiflora, laxa a densa; pedúnculo de (9–)13–35 cm de longitud; pedicelos de (1,5–)2–3,4(–4) cm de longitud, rectos a ligeramente curvos, lisos a débilmente estriados longitudinalmente, castaño oscuros. Nectarios reproductivos pedicelares cuculados a más frecuentemente cocleariformes, rojos, pedículos de los nectarios de (2–)3–6(–7) mm de longitud, urnas de 5–11 mm de longitud × 4–7 mm de ancho, dispuestos hacia el eje de la inflorescencia; los nectarios naciendo en el tercio, cuarto o quinto inferior del pedicelo. Flores 38–160; bractéolas sepaloides, subopuestas o alternas, ovadas a oblanceoladas, 1–2 mm de largo × ca. 1 mm de ancho, sosteniendo el cáliz o distanciadas 3–4(–6) mm de éste; sépalos orbiculares a suborbiculares, carnosos, de 1,5–2,1 mm de longitud; pétalos libres, ovados a oblongos, reflexos en la antesis, 5–6 mm de longitud × 2,5–3 mm de ancho, carnosos; estambres (14–)18–22, filamentos ca. 1,5 mm de longitud, aplanados, haciéndose más angostos hacia su porción distal, lisos, adnatos a la base de los pétalos, anteras introrsas, oblongas a ovales, subcordatas, ca. 2 mm de longitud × ca. 1 mm de ancho; ovario piriforme, liso a débilmente surcado, 2–3 mm de longitud; estigma mamiforme, subsésil, negruzco. Frutos globosos, apiculados, levemente rugosos, de 7–12 mm de diámetro; semillas semilunares, 5–6 mm de longitud × 1–1,5 mm de ancho, rugosas, reticuladas, negruzcas, brillantes, numerosas.

Distribución geográfica y ecología.—Schwartzia brasiliensis es endémica de la región oriental de Brasil (Bahia, Distrito Federal, Minas Gerais, Paraná, Pernambuco, Rio de Janeiro, Rio Grande do Norte, Santa Catarina y São Paulo) y crece en manglares, matas, matas de restinga, bordes de mata de restinga, afloramientos rocosos y en campos rupestres, entre el nivel del mar y los 1000 m.

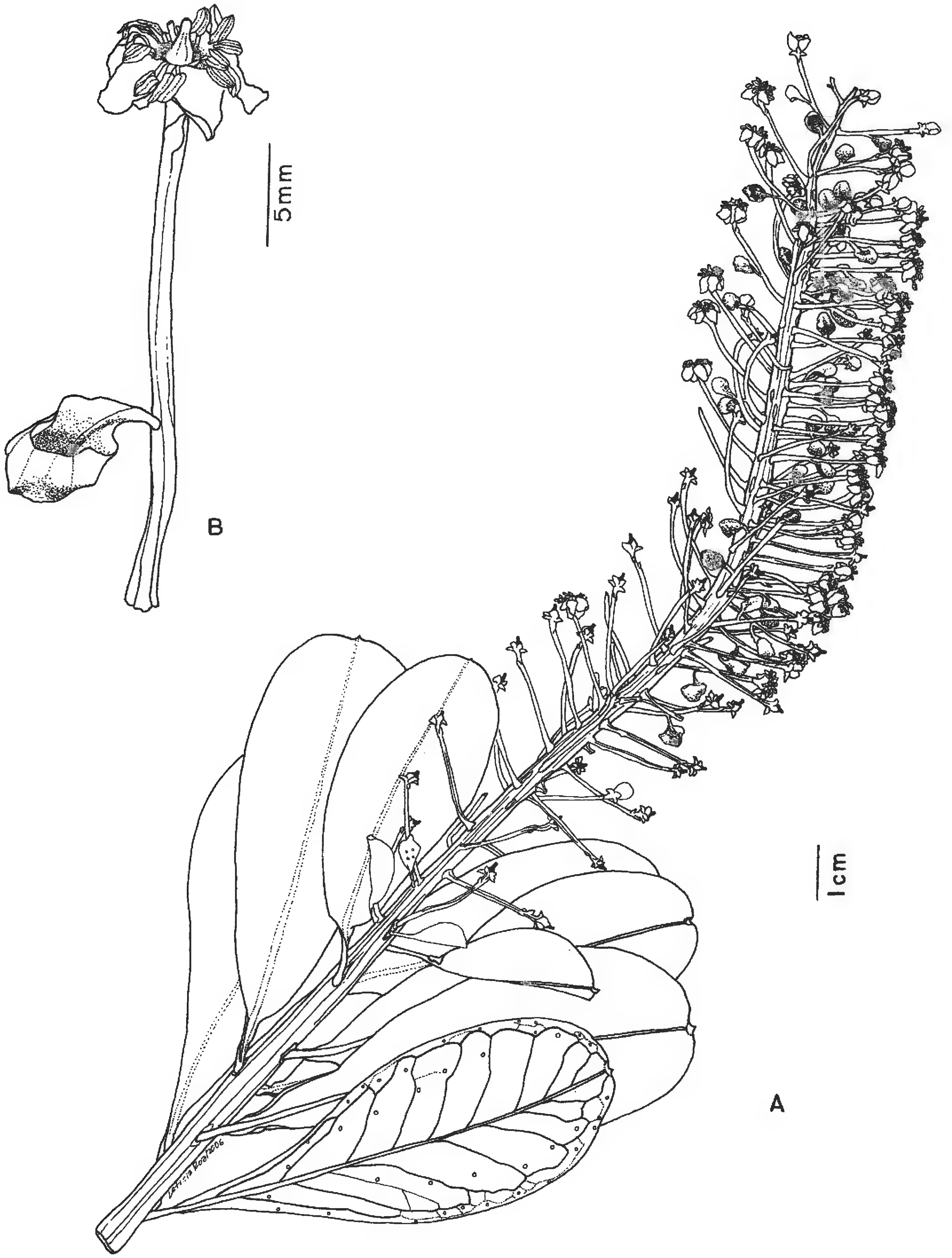


FIG. 4. *Schwartzia brasiliensis* (Choisy) Bedell ex Gir.-Cañas. **A.** Rama florífera. **B.** Flor y nectario reproductivo pedicelar. (*J. Pirani & O. Yano 561*).

Observaciones.—Schwartzia brasiliensis es la especie que presenta las inflorescencias más largas y las semillas más grandes entre todas las especies del género. Por otra parte, las inflorescencias de esta especie son visitadas por hormigas y pequeñas abejas (*Robim 666*), y su polinización se da por algunas especies de aves (Sazima et al. 1993). Véanse las observaciones dadas para *S. adamantium*. Cabe destacar que el binomio *Norantea bahiensis* Mart. ex Wittm. (Fl. Brasil. 12:245. 1878), es un *nomen nudum* que corresponde a la misma *S. brasiliensis*.

Especímenes examinados: **BRASIL. Bahia:** Região Cacaueira, Mun. Valença, estrada Valença-Guaibim, km 10 ap., 8 ene 1982, *A. de Carvalho & G. Lewis 1119* (US); on the coast road between Alcobaça and Prado, 10 km NW of Alcobaça, and 4 km N along road from the Rio Itanhentinga, sea level, 15 ene 1977, *R. Harley et al. 17940* (NY, dos ejemplares). Mun. Maracás, 8 a 18 km ao S de Maracás, pela antiga rodovia para Jequié, Capoeira de Mata de Cipó, 900–1000 m, 15 feb 1979, *T. dos Santos et al. 3481* (SP); Sin localidad y sin fecha, año 1841, *Martius 1048* (MO, NY). **Distrito Federal:** Praia de Sernambetiba, Recreio dos Bandeirantes, sea level, 4 abr 1952, *L. Smith et al. 6407* (NY, US). **Minas Gerais:** Rio Preto, 16 km da praça central de Rio Preto, na estrada para o Rio do Funil, localidades de São Gabriel, próximo à ponte do riacho São Gabriel, Sopés da Serra Negra, divisa com Lima Duarte, 820 m, 26 feb 1999, *R. Mello-Silva et al. 1644* (SP). **Paraná:** Jacarahy, ad marginem silvaloe, 12 may 1909, *P. Dusén 8116* (MO, NY, US); Jacarahy, 24 mar 1911, *P. Dusén 18196* (SI); swampy brejo, N of Río Nunes, N of Morretes, 40 m, 24 ene 1985, *A. Gentry & E. Zardini 49801* (MO); Paranagua, Matinhos, 7 mar 1951, *G. Hatschbach 2149* (SI). Mun. Paranaguá, Rio Cachoeirinha, 10 m, 19 jun 1970, *G. Hatschbach 24409* (NY). Mun. Guaratuba, rio Quiririm, mata pluvial, 50 m, 1 abr 1973, *G. Hatschbach 31796* (COL). Mun. Guaraqueçaba, Morro do Quitumbe, 9 feb 1994, *R. Lima 228* (NY); Guaratuba, restinga, 3 m, 21 feb 1952, *P. Reitz 4369* (RSA). Mun. Guaratuba, low coastal forest, Guaratuba, 2 m, 21 feb 1952, *L. Smith & P. Reitz 5754* (US). **Pernambuco:** Sin localidad, años 1836–1841, *G. Gardner 942* (NY, dos ejemplares); in a thicket, Tapera, 21 dic 1934, *D. Pickel 3737* (F, NY). **Rio de Janeiro:** Restinga al S de Copacabana, 7 feb 1974, *A. Burkart 30358* (SI); Rio de Janeiro, restinga de Jacarepaguá, 0–10 m, 3 nov 1962, *J. Cuatrecasas & A. Duarte 26633* (US); Rio de Janeiro, Recreio dos Bandeirantes, 7 feb 1964, *W. Hoehne 5585* (COL); Recreio dos Bandeirantes, 30 km W of Rio de Janeiro, 5 mar 1964, *K. Lems s.n.* (NY); Furnas, nos blocos de pedras, 19 dic 1928, *A. Ducke 12801* (US). Mun. Maricá, restinga alagada próximo a S. José do Imcaçaí, 23 nov 1983, *C. Farney & E. Landolt 375* (NY). Mun. Cabo Frio, Massambaba, a 39 km paria de Iguaba e a 14 km do Trevo de Cabo Frio, 5 feb 1986, *Fontellah et al. 2294* (NY); Restinga de Macaé, ca. 10 m, 11 ene 1985, *A. Gentry et al. 49432* (MO); Pedra da Itauna, 9 oct 1977, *P. Maas & P. Carauta 3135* (NY). Mun. Paraty, Na beira do mar, em direção a enseada da praia do Saco da Vehla, lado direito, 5 feb 1989, *R. Marquete 206* (F, IBGE); Macaé, entre Macaé e Rio das Ostras, 15 may 1993, *R. Mello-Silva & J. Pirani 868* (NY); Serra dos Orgáos (?, letra ilegible), prox. Pedra do Farrafas, 25 ene 1977, *P. Occhioni s.n.* (IBGE: 16245); swamp, vicinity of Angra dos Reis, 1 feb 1968, *L. Smith & E. McWilliams 15365* (US). **Rio Grande do Norte:** Along sand-dunes about 2 miles N of Ponta Negra, S of Natal, 8 sep 1946, *J. Wurdack 165* (NY). **Santa Catarina:** Mun. Ilhota, Morro do Baú, 30 ene 1964, *E. Pereira & G. Pabst 8783* (NY); Brusque, 50 m, 23 feb 1950, *P. Reitz 3359* (SI, dos ejemplares); Braço Joaquim, Luis Alves, Itajaí, 450 m, 16 feb 1956, *Reitz & Klein 2712* (NY, US); Pilões, Palhoça, 350 m, 23 feb 1956, *Reitz & Klein 2850* (NY, US); Salto de Pilão, Lontras, Rio do Sul, 300 m, *Reitz & Klein 8626* (US). Mun. Pôrto Belo, strand and rocky woods, eastern shore of Ilha João da Cunha, 1–5 m, 31 mar 1957, *L. Smith et al. 12293* (US); Isla do Francés, feb 1947, *B. de Stienstra 42* (SI, dos ejemplares). **São Paulo:** Sergipe, entre Areia Branca e Itabaina, alto da serra de Itabaina, ca. 600 m, 25 ene 1992, *F. de Barros 2445* (SP); Ubatuba, km 242 da rodovia São Paulo-Ubatuba, 26 feb 1964, *N. Cruz 86* (SP). Mun. Cananéia, island of Cananéia, about 1 km NE of center of city of Cananéia, along east shore of the island, sea level, 17 feb 1965, *G. Eiten & W. Clayton 6186* (MO, NY, SP: tres ejemplares). Mun. Ubatuba, à 20 m da ponte do Rio Escuro, 9 dic 1961, *J. Fontella 119* (SP, US); Cubatão, 15 mar 1923, *A. Gehrt 8223* (SP); São Sebastian, Bertioga, 10 nov 1976, *P. Gibbs et al. 3513* (NY); Santos-São Sebastian, km 40, rio Guaratuba, 1 abr 1976, *S. Hallard 4* (NY); São Paulo, nativa no Jardim Botânico, 10 feb 1935, *O. Handro s.n.* (SP: 32835, dos ejemplares). Mun. Santo André, Ribeirão Pires, 16 ene 1949, *G. Hashimoto 586* (SP, US); Bertioga, bairro de Boracéia, Condomínio Morada da Praia, ca. km 193,5 da BR-101-Rio-Santos, 24 mar 2000, *M. Kirizawa et al. 3406* (COL); Vilha Atlantica, 7 jul 1951, *J. Morello 63* (SI); Salesópolis, Estação Biológica de Boracéia, perto do Rio Coruja, 29 nov 1966, *J. Mattos & N. Mattos 14253* (SP); cultivada em Piracicaba, na Escola Agricola Luiz de Queiroz, 26 mar 1934, *P. de Oliveira Santos s.n.* (SP: 31673); Cananéia, mata de restinga, 25 feb 1983, *J. Pirani & O. Yano 561* (COL); Ilha Anchieta, praia das palmas, restinga, 10 ene 1991, *M. Robim 666* (COL); Sin fecha, *H. Mosén 3160* (MO); Sin Estado y sin localidad, años 1822–1828, *L. Riedel 831* (NY); Sin Estado, sin localidad y sin fecha, *Santos 75* (NY); Sin Estado, sin localidad y sin fecha, *Luschnath 137-159* (MO).

5. Schwartzia chocoensis Gir.-Cañas, Revista Acad. Colomb. Ci. Exact. 25(97):478. 2001. (**Fig. 5**). Tipo: COLOMBIA. Chocó: Carretera Ansermanuevo-San José del Palmar, 8,4 km del Alto del Galápago, 1600 m, 19 feb 1977, *E. Forero, A. Gentry, A. Sugden & D. Daly 3000* (holotipo: COL!; isotipos: CHOCO!, MO!).

Schwartzia foreroi de Roon & Bedell, in Forero & Gentry, Lista anotada de las plantas del departamento del Chocó, Colombia. Biblioteca José Jerónimo Triana 10:103. 1989, *nomen nudum*.

Arbustos escandentes, epífitos a hemiepífitos, profusamente ramificados, ramas robustas; tallos cilíndricos, huecos o fibrosos internamente, entonces las fibras lanuginosas, corteza castaño a ferrugínea, fuertemente estriada y rugosa, las estrías tranversales. Hojas cortamente pecioladas; pecíolo recurvado, canaliculado (el canal muy angosto y poco profundo, ca. 1 mm de ancho), levemente estriado a más comúnmente liso, castaño

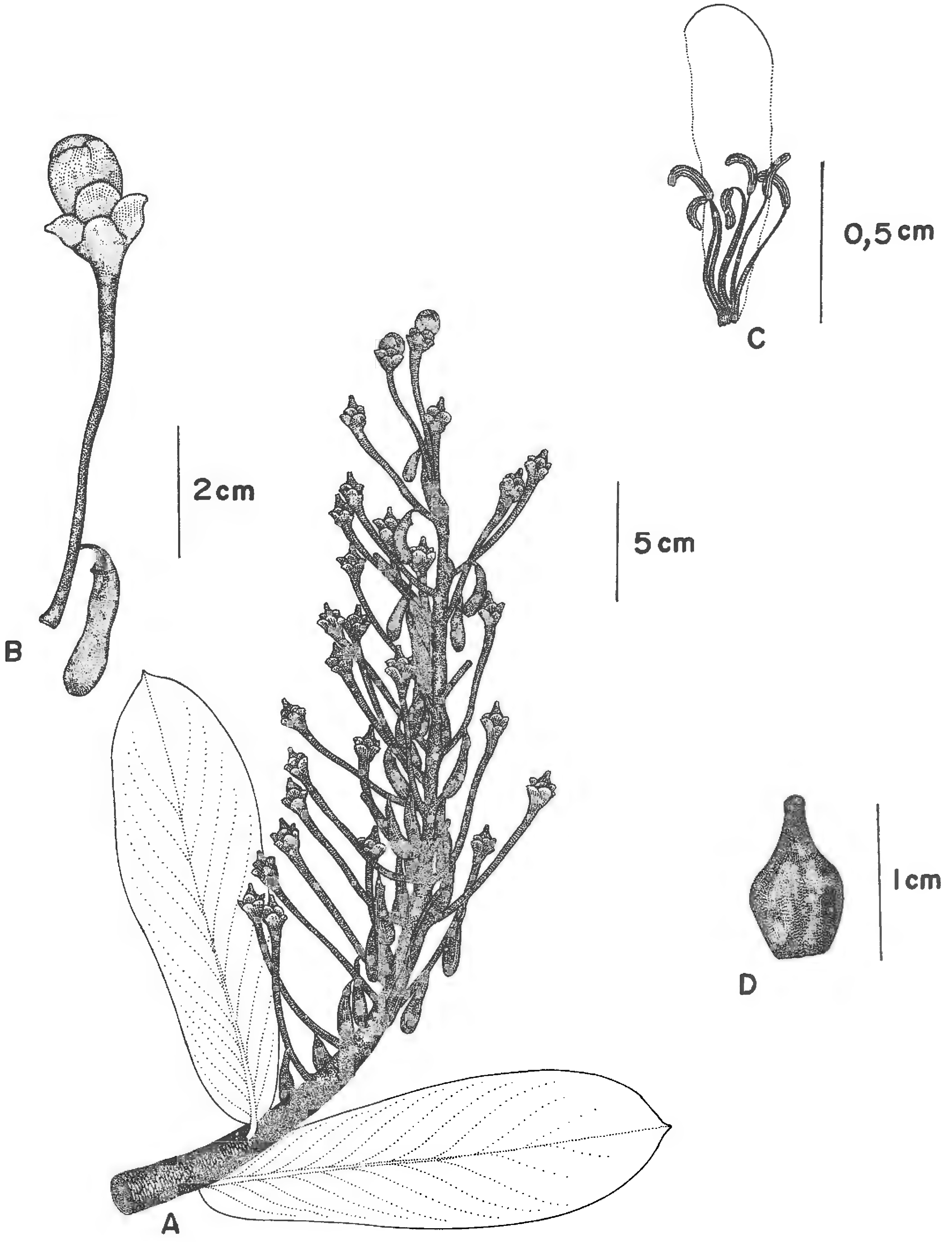


Fig. 5. *Schwartzia chocoensis* Gir.-Cañas. A. Rama florífera. B. Botón floral y nectario reproductivo pedicelar. C. Detalle de los estambres. D. Ovario. (*E. Forero et al. 3000*).

oscuro, de (3–)4–6(–10) mm de longitud × 5–6(–7) mm de ancho; láminas elípticas a oblongas, de (12–)15–22 cm de longitud × (3,5–)5,5–7,8(–8,2) cm de ancho, de base levemente cordata y ápice cortamente apiculado, con márgenes ligeramente revolutas y engrosadas, usualmente pruinosas en la haz; nervio medio conspicuo en ambas caras (aunque poco notorio hacia la porción distal de la haz), plano a levemente hundido en la haz y abultado en el envés, liso, de 1–2 mm de ancho; venación secundaria débil en ambas caras; 2–7 pares de glándulas laminales en la superficie abaxial, submarginales, localizadas a 0,5–1,5(–3) mm de la margen, circulares, levemente elevadas, de ca. 0,8 mm de diámetro, con su orificio circular, negruzco, de ca. 0,15 mm de diámetro, distanciadas entre si 1,5–6(–7) cm. Inflorescencia terminal, racemosa, multiflora, densa; pedúnculo de 5–30 cm de longitud; pedicelos de 4–5,8(–7) cm de longitud, rectos a ligeramente sinuosos, lisos a levemente estriados, castaño oscuros. Nectarios reproductivos pedicelares sacciformes a tubulares, péndulos, rojizos, estriados longitudinalmente, ligeramente rugosos, pedículos de los nectarios 1–2 mm de longitud, urnas de (15–)20–33 mm de longitud × 5,5–10 mm de ancho, con los orificios circulares, de 1,5–3 mm de diámetro, dispuestos hacia el eje de la inflorescencia y ocupando una posición oblicua respecto a su eje, el orificio usualmente con un pequeño apéndice en forma de espolón (rostrado) de 0,5–2,5 mm de longitud; los nectarios naciendo en el tercio, cuarto o quinto inferior del pedicelo. Flores 5–54, inserción pedicelo-flor horizontal a levemente oblicua; bractéolas sepaloides, opuestas, orbiculares, obtusas, rugosas, carnosas, breves, de 2,5–5 mm de longitud; sépalos orbiculares, rugosos, carnosos, de 4–7 mm de longitud; pétalos connatos basalmente ca. 1/6 de su longitud, ovados, reflexos en la antesis, de 6–12(–13) mm de longitud × 3,8–6 mm de ancho, carnosos, verde claros a rojizos; estambres 50, filamentos de 1–3 mm de longitud × ca. 0,5 mm de ancho, aplanados, levemente verruculosos, adnatos a la base de los pétalos, anteras oblongas, basifijas, subcordatas, blanquecinas, 3–5 mm de longitud × 0,5–1 mm de ancho; ovario cónico, ligeramente estriado, 3–8 mm de longitud × 2,5–6 mm de ancho; estigma mamiforme, subsésil, negruzco. Frutos globosos, carnosos, apiculados, lisos, de 14–17 mm de diámetro, verde claros; semillas reniformes, 3–4 mm de longitud × ca. 1,5 mm de ancho, rugosas, negruzcas, brillantes, numerosas (ca. 30 por fruto).

Distribución geográfica y ecología.—Schwartzia chocoensis crece en bosques maduros, en manglares, en bosques secundarios, en riberas de grandes ríos y en bordes de bosques de áreas muy húmedas a pluviales, entre el nivel del mar y los 1600 m de altitud. Hasta ahora sólo ha sido recolectada en Colombia y Ecuador.

Observaciones.—Los nectarios reproductivos pedicelares de *S. chocoensis* producen una gran cantidad de néctar, pues éste alcanza a llenar casi completamente el volumen de éstos (vistos en corte longitudinal). Véanse las observaciones dadas para *S. antioquensis* y *S. renvoizei*.

Especímenes examinados: **COLOMBIA. Chocó:** 4 km de Quibdó hacia Guayabal, al lado de la carretera, junto al río Hugó, ca. 50 m, 9 ago 1982, *L. Albert de Escobar et al. 2229* (HUA); Carretera Quibdó-Guayabal, Duatá, margen derecha del río Duatá, 40 m, 27 abr 1975, *E. Forero et al. 1293* (COL, MO, NY); banks of Quebrada Togoromá, 13 jun 1944, *E. Killip & J. Cuatrecasas 39159* (US). **Valle del Cauca:** vicinity of Buenaventura, Bajo Calima Region, between Buenaventura and Río Calima, km 22 on main road to Canalete, ca. 6 km N of main road, 50–60 m, 21 jul 1988, *T. Croat 69454* (MO); Bajo Calima, ca. 100 m, 25 mar 1961, *I. Cabrera 440* (COL); Bajo Calima, ca. 10 km due N of Buenaventura, Cartón de Colombia Concession, transition between tropical wet and pluvial forest, 3°56'N-77°08'O, ca. 50 m, 7 dic 1981, *A. Gentry 35421* (COL, MO); Bahía Málaga, mangroves, mouth of Quebrada Sierpe, 4°0'N-77°15'O, sea level, 17 feb 1983, *A. Gentry et al. 40423* (COL, MO); Bajo Calima, Dindo area, 3°59'N-76°58'O, ca. 100 m, 11 jul 1984, *A. Gentry et al. 47886* (COL, MO). Mun. Buenaventura, quebrada San Joaquín, Concesión Pulpapel, 100 m, 7 may 1968, *J. Idrobo et al. 6195* (COL, dos ejemplares); Costa Pacífica, Bahía Málaga, quebrada Valencia, 24 jul 1987, *L. Millán 61* (CUVC); Río El Chanco, margen izquierda, camino que conduce a Aguabonita, subiendo hacia la cabecera del río El Chanco, 400 m, 3 abr 1985, *R. Ruiz et al. 94* (COL). **ECUADOR. Pichincha:** km 110 Quito-Nono-Tandayapa-Mindo-Puerto Quito, 1100 m, 1–24 jul 1982, *C. Dodson & A. Embree 13091* (MO).

6. Schwartzia geniculatiflora Gir.-Cañas & Fiaschi, Caldasia 27:185. 2005. (**Fig. 6**). TIPO: BRASIL. BAHIA: Uruçuca, 7,3 km north of Serra Grande on road to Itacaré, Fazenda Lagoa do Conjunto Fazenda Santa Cruz, southern Bahian wet forest, 14°25'24"S, 39°03'38"W, 15 nov 1995, *W.W. Thomas, A.M. de Carvalho, J. Jomar & G. Pitanga 11029* (HOLOTIPO: COL!; ISOTIPOS: CEPEC!, COL!, NY!).

Arbustos hemiepífitos, escandentes, ramas decumbentes; tallos cilíndricos a subteretes, corteza castaña clara, estriada longitudinalmente. Hojas cortamente pecioladas, pecíolo engrosado, recurvado, canaliculado, liso a levemente estriado, castaño oscuro, hasta de 8 mm de longitud; láminas obovadas, de 5–8 cm de longitud × 2,5–3,5 cm de ancho, de base redondeada a levemente asimétrica y ápice obtuso y/o diminuta-

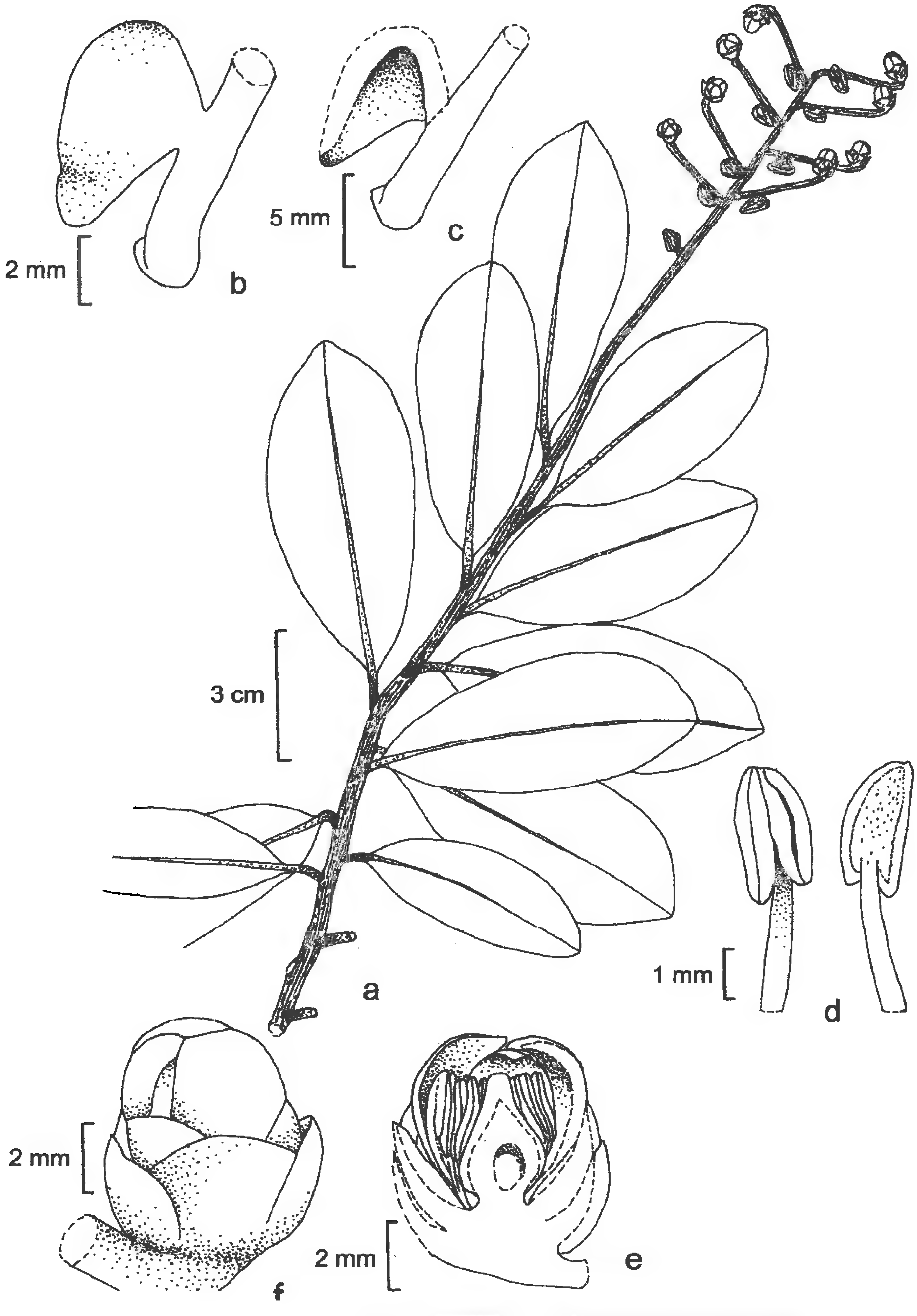


Fig. 6. *Schwartzia geniculatiflora* Gir.-Cañas & Fiaschi. A. Rama florífera. B. Nectario reproductivo pedicelar. C. corte longitudinal de un nectario reproductivo pedicelar. D. Detalle de los estambres. E. Corte longitudinal de una flor antes de la antesis. F. Detalle de la flor antes de la antesis; nótese en E y F la posición oblicua de la flor en el pedicelo (*W. W. Thomas et al. 11029*).

mente mucronado, con márgenes planas o levemente revolutas; nervio medio conspicuo en ambas caras, desvaneciéndose hacia su porción distal, plano en la haz y ligeramente elevado en el envés, liso; venación secundaria suprimida en ambas caras; 1–4 pares de glándulas laminales en la superficie abaxial, ubicadas en la parte media a distal de la lámina sin presentarse en la parte basal de la misma, dispuestas en una fila más o menos regular a ambos lados de la cara abaxial, distanciadas 1–6 mm de la margen, elípticas, conspicuamente distanciadas entre sí, ca. 1,5 mm de largo × ca. 1 mm de ancho, con su orificio elíptico, negruzco. Inflorescencia terminal, racemosa, pauciflora, laxa; pedúnculo de 6–6,5 cm de longitud; pedicelos de 1,7–2 cm de longitud, rectos, casi perpendiculares con relación al eje de la inflorescencia, lisos, castaño oscuros. Nectarios reproductivos pedicelares galeados, péndulos, sésiles, urnas de ca. 5 mm de longitud × ca. 4 mm de ancho, con la boca elipsoide dispuesta hacia el eje de la inflorescencia; los nectarios naciendo en el cuarto proximal del pedicelo. Flores 8–10, inserción pedicelo-flor oblicua; bractéolas sepaloides, opuestas, orbiculares, carnosas, ca. 2,5 mm de diámetro, sosteniendo el cáliz; sépalos orbiculares, carnosos, ca. 3,5 mm de diámetro; pétalos libres, ovados, carnosos, ca. 5 mm de longitud; estambres 18, filamentos ca. 2,7 mm de longitud, aplanados, libres, anteras oblongas, subsagitadas, ca. 2,6 mm de longitud × ca. 1,5 mm de ancho; ovario cónico, ca. 3,2 mm mm de longitud; estigma subsésil, mamiforme, negruzco. Frutos globosos, conspicuamente apiculados, rugosos, ca. 10 mm de diámetro, más la porción apiculada de ca. 3 mm de longitud; semillas oblongas a reniformes, rugosas, reticuladas, negruzcas, brillantes, numerosas.

Distribución geográfica y ecología.—*Schwartzia geniculatiflora* es endémica de los bosques húmedos del sur de Bahia, conociéndose sólo de la localidad tipo.

Observaciones.—*Schwartzia geniculatiflora* es fácilmente reconocible por la forma del nectario reproductivo pedicelar y, principalmente, por la posición conspicuamente oblicua de la flor en el pedicelo, característica poco frecuente en el género, encontrándose, aunque no tan notoriamente como en *S. geniculatiflora*, en las especies andinas o chocoanas *S. andina* Gir.-Cañas, *S. chocoensis* Gir.-Cañas, *S. parrae* Gir.-Cañas y *S. renvoizei* Gir.-Cañas.

7. Schwartzia jucuensis Gir.-Cañas, Darwiniana 42:173. 2004. (**Fig. 7**). TIPO: BRASIL. ESPÍRITO SANTO: Mun. Domingos Martins, Chapéu, Rio Jucu, Braço Norte, margens de rio, sobre rochas, 8 nov 1993, *G. Hatschbach, M. Hatschbach & J. Silva 59728* (HOLOTIPO: US!; ISOTIPOS: CEPEC, MBM).

Arbustos escandentes, hemiepífitos; tallos cilíndricos, angulosos en las porciones distales de las ramas, levemente estriados; corteza castaño clara en las porciones proximales de las ramas, negruzca en las porciones distales. Hojas pecioladas; pecíolo recurvado, canaliculado, ligeramente estriado, negruzco, de 10–23 mm de longitud; láminas oboelípticas a obovadas, de 7–8,5 cm de longitud × 3,8–4,2 cm de ancho, de base cuneada y ápice obtuso y retuso, con márgenes planas o ligeramente revolutas y engrosadas; nervio medio conspicuo en ambas caras, desvaneciéndose hacia su porción distal, plano o levemente hundido en la haz y abultado en el envés, liso a estriado longitudinalmente; venación secundaria débilmente impresa en ambas caras; 1–7 pares de gándulas laminales en la superficie abaxial, circulares, ca. 1 mm de diámetro, submarginales, a 0,5–3(–7) mm de la margen. Inflorescencia terminal, racemosa, multiflora, densa; pedúnculo de 4 cm de longitud; pedicelos de 3,9–4,8 cm de longitud, capilares, rectos, lisos a débilmente estriados longitudinalmente, castaño oscuros. Nectarios reproductivos pedicelares tubuloso-sacciformes, pedículos de los nectarios de 3–6 mm de longitud, urnas de 7–10 mm de longitud × 2–2,5 mm de ancho, con la boca dispuesta hacia el eje de la inflorescencia; los nectarios naciendo en el cuarto o quinto inferior del pedicelo. Flores 22; bractéolas sepaloides, opuestas, deltoides, de 1,7–2 mm de longitud × 1,4–2 mm de ancho, sosteniendo el cáliz; sépalos suborbiculares, carnosos, de 1,8–2 mm de longitud; pétalos ovados, libres, carnosos, de 4,7–5,2 mm de longitud; estambres ca. 15, filamentos ca. 1,3 mm de longitud, aplanados, lisos, adnatos a la base de los pétalos, anteras introrsas, oblongas, subcordatas, ca. 2,5 mm de longitud × ca. 1 mm de ancho; ovario cónico, débilmente estriado longitudinalmente, ca. 3 mm × ca. 2 mm; estigma mamiforme, subsésil, negruzco. Frutos desconocidos.

Distribución geográfica y ecología.—*Schwartzia jucuensis* sólo se conoce de la localidad tipo, en la región sudeste de Brasil, estado de Espírito Santo, creciendo en las márgenes rocosas del río Jucu.

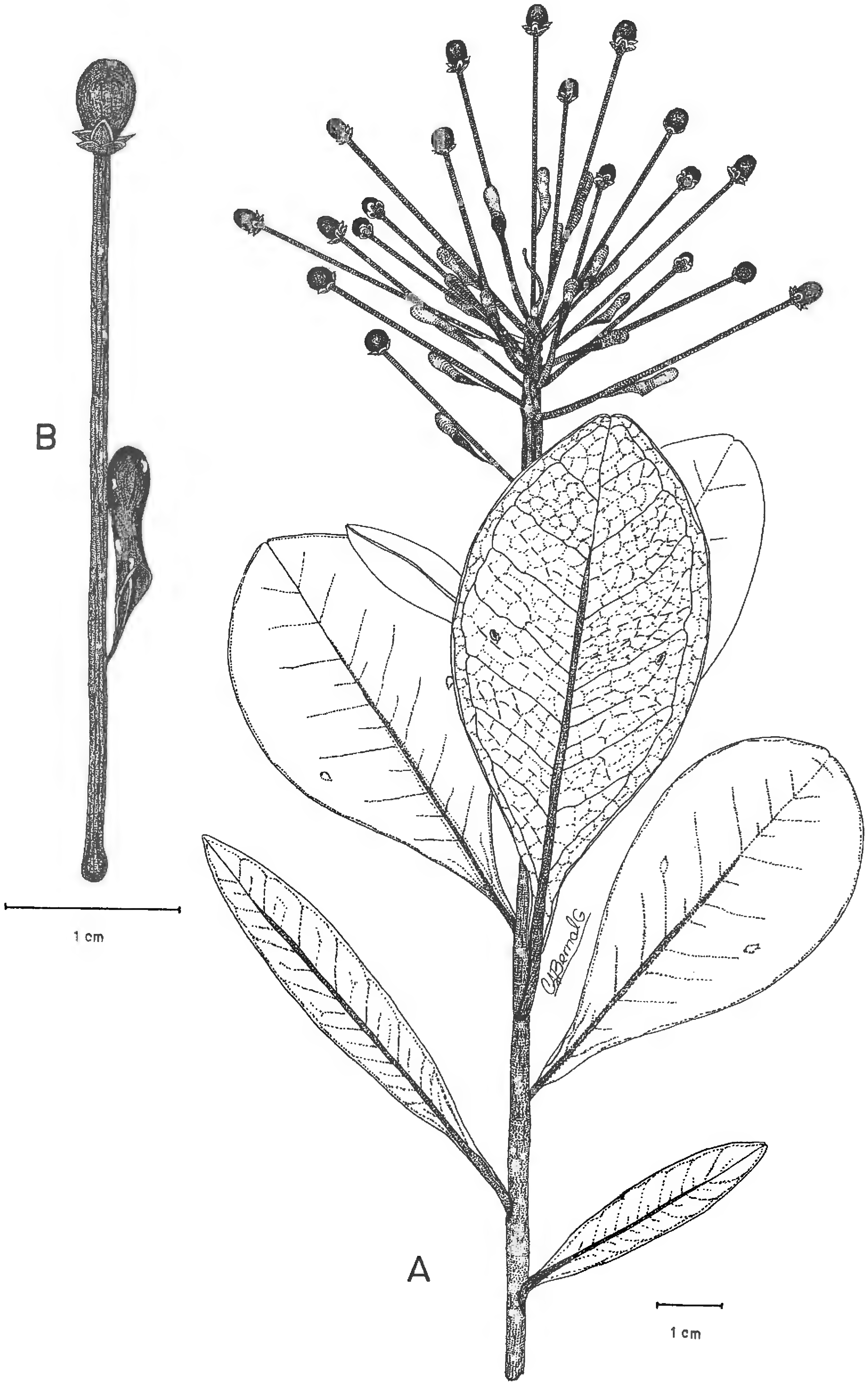


Fig. 7. *Schwartzia jucuensis* Gir.-Cañas. **A.** Rama florífera. **B.** Botón floral y nectario reproductivo pedicelar. (*G. Hatschbach et al. 59728*).

Observaciones.—Esta especie es única en el género por su inflorescencia densa y cortamente racemosa (pedúnculo de 4 cm de longitud y raquis ca. 2,5 cm de longitud), sus delicados pedicelos de 3,9–4,8 cm de longitud, sus pequeños nectarios reproductivos pedicelares sacciforme-tubulares y con pedículos hasta de 6 mm de longitud, sus pequeñas flores (4,7–5,2 mm de alto × 3,8–4 mm de ancho), sus bractéolas deltoides y por sus largos pecíolos (hasta de 23 mm).

8. Schwartzia lozaniana Gir.-Cañas, Caldasia 23:384. 2001. (**Fig. 8**). TIPO: COLOMBIA. NARIÑO: Junín-Tumaco road, 6–11 km W of Junín, roadside thickets and forest edge, 850–1030 m, 27 feb 1979, *J. Luteyn & M. Lebrón-Luteyn 6880* (HOLOTIPO: COL!; ISOTIPOS: MO!, NY!).

Arbustos escandentes, con ramas péndulas hasta de 4 m de longitud; tallos triangulares a cilíndricos o irregularmente aplanados, levemente estriados, huecos; corteza castaño, ferrugínea a cobriza. Hojas pecioladas; pecíolo ligeramente estriado, recurvado, canaliculado (el canal muy angosto, ca. 1 mm de ancho), castaño claro a negruzco, de 9–32 mm de longitud; láminas oblongas a elípticas, de (7)13–19 cm de longitud × 4–10 cm de ancho, de base redondeada y ápice acuminado y levemente asimétrico, con márgenes ligeramente revolutas y engrosadas; nervio medio conspicuo en ambas caras, elevado en la haz y plano a levemente abultado en el envés, estriado, de 1–1,3 mm de ancho; venación secundaria débil; 0–6 pares de glándulas laminales en la superficie abaxial (algunas láminas no presentan glándulas), submarginales, localizadas a 2–4,5 mm de la margen, elípticas, de 1,5 mm de largo × 0,7 mm de ancho, con su orificio negruzco de 0,5 mm de largo × 0,25 mm de ancho, distanciadas entre si 1–5 cm. Inflorescencia terminal, racemosa, multiflora, densa; pedúnculo de 6,5–18 cm de longitud; pedicelos de (3–)5–6(–7) cm de longitud, rectos a flexuosos, estriados, un poco más gruesos en su porción distal, castaño oscuros, cada uno con una bráctea nectarífera (nectario). Nectarios reproductivos pedicelares sacciformes, tubulares, péndulos, purpúreos, estriados longitudinalmente, pedículos de los nectarios ca. 1 mm de longitud, urnas de (9–)13–15(–17) mm de longitud × 3–6 mm de ancho, boca rostrada, con el orificio elíptico a circular, de 1,3–2,8 mm de ancho, dispuesta hacia el eje de la inflorescencia y ocupando una posición transversal respecto a su eje; los nectarios naciendo por debajo del 1/3 proximal del pedicelo. Flores 18–68, inserción pedicelo-flor horizontal; bractéolas sepaloides, opuestas, orbiculares, obtusas, rugosas, carnosas, breves, ca. 2 mm de longitud, márgenes translúcidas; sépalos orbiculares, rugosos, carnosos, 2,2–2,8 mm de longitud, márgenes translúcidas; pétalos connatos basalmente por ca. 2/3 de su longitud, obovado-elípticos, reflexos en la antesis, de 6,5–10 mm de longitud × ca. 3 mm de ancho, carnosos; estambres ca. 25, filamentos de 3–5 mm de longitud, aplanados, verruculosos, adnatos a la base de los pétalos, anteras oblongas, subcordatas, de 2–3 mm de longitud; ovario cónico, ligeramente estriado, ca. 2,5 mm de longitud × ca. 1,5 mm de ancho; estigma mamiforme, subsésil, negruzco. Frutos inmaduros globosos, apiculados, sulcados longitudinalmente, de 2,2–3 mm de diámetro, negruzcos.

Distribución geográfica y ecología.—*Schwartzia lozaniana* sólo se conoce de la vertiente occidental andina en el departamento de Nariño (sur de Colombia) y de las provincias de Carchi y Esmeraldas (Ecuador), áreas pertenecientes al Chocó Biogeográfico. Esta especie, como muchas otras de la familia Marcgraviaceae, crece en bordes de bosques de zonas húmedas a muy húmedas, entre los 500 y los 1600 m.

Observaciones.—*Schwartzia lozaniana* es la especie que presenta los pecíolos más largos (hasta de 32 mm), mientras que en las demás especies éste sólo alcanza hasta los 14(–23) mm de longitud. Los nectarios reproductivos pedicelares de *S. lozaniana* producen una gran cantidad de néctar, según se infiere de las manchas dejadas por éste en el interior de los nectarios (vistos en corte longitudinal), alcanzando a llenar un poco más de la mitad de su volumen. Los binomios *Schwartzia venusta* Bedell (*in sched.*) y *Schwartzia venusta* de Roon & Bedell (*in sched.*) son nombres no publicados que corresponden a *S. lozaniana*.

Especímenes examinados: **COLOMBIA. Nariño:** Mun. Ricaurte, corregimiento de Altaquer, 1600 m, 19 feb 1977, *O. de Benavides 893* (PSO). Mun. Barbacoas, corregimiento de Junín, 1200 m, 7 oct 1988, *O. de Benavides 10252* (COL, PSO); 2–8 km E of Junín on Tumaco-Túquerres road, 1100 m, 26 jul 1986, *A. Gentry et al. 55249* (MO, PSO). Mun. Barbacoas, corregimiento El Diviso, camino al Caraño, 580–600 m, 23 ago 1995, *M. González et al. 1057* (PSO). Mun. Barbacoas, km 2 trayecto Junín-Barbacoas, 1150 m, 14 abr 1989, *B. Ramírez 1334* (PSO). **ECUADOR. Carchi:** Trail to Río Gualpi Chico, along ridge line near Awa encampment, 1330 m, 17 ene 1988, *W. Hoover et al. 2538* (MO). Border area between Prov. Carchi and Esmeraldas, about 20 km past Lita on road Lita-Alto Tambo, 550 m, 25 jun 1991, *H. van der Werff et al. 11992* (MO). **Esmeraldas:** Quinindé Cantón, Bilsa Biological Station, Reserva Ecológica Mache-Chindul, 40 km NW

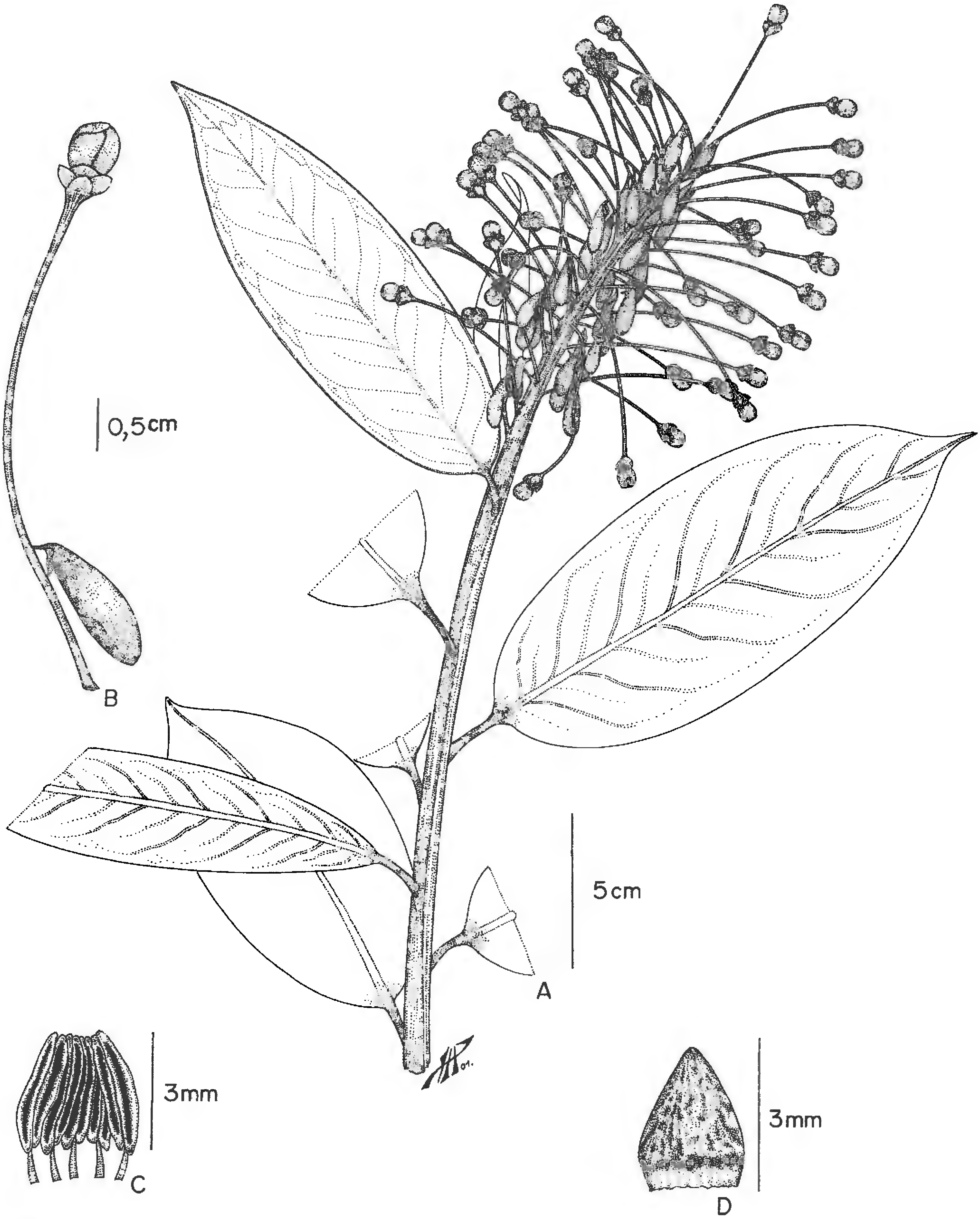


Fig. 8. ***Schwartzia lozaniana*** **Gir.-Cañas. A. Rama florífera. B. Botón floral y nectario reproductivo pedicelar. C. Detalle de los estambres. D. Ovario. (*J. Luteyn 6880*).**

of Quinindé, Loma de los Guerrilleros, premontane wet forest, 650 m, 12 mar 1997, *J. Clark et al. 3974* (COL); Lita-San Lorenzo road, 18 km W of Río Lita Bridge, on old road below Lita, 6.6 km W of bridge over Río Chuchubí, site near Alto Tambo, 425 m, 10 jul 1998, *T. Croat et al. 82631* (MO). Lita-San Lorenzo road, 10–20 km NW of Lita, 800 m, 12 may 1991, *A. Gentry et al. 70088* (MO).

9. Schwartzia magnifica (Gilg) Bedell, Monogr. Syst. Bot. Missouri Bot. Gard. 45:1256. 1993. (**Fig. 9**). *Norantea magnifica* Gilg, Bot. Jahrb. Syst. 42:127. 1908. TIPO: PERÚ. HUÁNUCO: near Monzón, 2000 m, *A. Weberbauer 3528* [LECTOTIPO: MOL, designado por Giraldo-Cañas (2006); fotografías en F!, MO!].

Arbustos escandentes, hemiepífitos, ramas robustas, tallos levemente angulosos. Hojas cortamente pecioladas; pecíolo recurvado, canaliculado, levemente estriado, castaño oscuro, de 3–4 mm de longitud × ca. 3 mm de ancho; láminas obovadas, de 9–12,5 cm de longitud × 5,5–6,8 cm de ancho, de base cuneada y ápice redondeando y cortamente apiculado, con márgenes ligeramente revolutas y engrosadas; nervio medio conspicuo en ambas caras, aunque se va desvaneciendo hacia la porción distal, plano a levemente hundido en la haz y ligeramente abultado en el envés; venación secundaria apenas perceptible en la haz y suprimida en el envés; 15–24 pares de glándulas laminales en la superficie abaxial, submarginales hacia la parte distal de la lámina, localizadas a 2–13 mm de la margen, elípticas, ca. 05 mm, distanciadas entre si 0,1–0,4(–9) mm. Inflorescencia terminal, racemosa, multiflora, densa; pedúnculo de 10–14 cm de longitud; pedicelos de 4,4–5,5 cm de longitud (hasta de 9 cm de longitud en fruto), sinuosos, lisos, castaño oscuros. Nectarios reproductivos pedicelares sacciformes a tubulares y ligeramente rostrados, péndulos, pedículos de los nectarios 1–5 mm de longitud, urnas de 12–17 mm de longitud × 4,5–7 mm de ancho, con los orificios dispuestos hacia el eje de la inflorescencia; los nectarios naciendo en el tercio inferior del pedicelo. Flores 18–28; bractéolas sepaloides, orbiculares, carnosas, de 5–6 mm de longitud; sépalos orbiculares, carnosos, de 6,5 mm de longitud; pétalos ovados, connatos basalmente, carnosos, ca. 9 mm de longitud × ca. 5 mm de ancho; estambres 13, filamentos ca. 3 mm de longitud × ca. 0,6 mm de ancho, aplanados, lisos, libres, anteras oblongas, ca. 2,5 mm de longitud × ca. 1,5 mm de ancho; ovario cónico, de 3 mm de longitud; estilo ca. 1 mm de longitud; estigma mamiforme, ca. 1 mm de diámetro. Frutos inmaduros globosos, ca. 1 cm de diámetro, apiculados, el apículo ca. 0,25 cm de longitud.

Distribución geográfica y ecología.—*Schwartzia magnifica* es endémica de los bosques de niebla de la región andina de Huánuco y el sur de la Cordillera Vilcabamba (Perú) y crece entre los 2000 y los 2500 m. Esta especie, al igual que otras especies de los bosques montanos peruanos, se encuentra bajo amenaza por la deforestación y la expansión agrícola (León & Monsalve 2006).

Observaciones.—El holotipo depositado en el herbario de Berlín (B) fue destruido y no se conocía ningún otro material de la especie, a excepción del isotipo de MOL y del ejemplar *A. Weberbauer 7071* de Perú (B destruido; fotografías F!, MO!, NY!) correspondiente a *Norantea thyrsiflora* Gilg (*in sched.*, igual a *S. magnifica*), hasta que estudié los ejemplares *P. Núñez et al. 23484* (NY, US), los cuales estaban determinados como *Norantea macrocephala* G. Don en NY y como *Norantea macrocarpa* G. Don en US. Después del estudio detallado de estos especímenes, pude advertir que se trataba de *Schwartzia magnifica*, lo que se convierte en el redescubrimiento de la especie.

Especímenes examinados: **PERÚ. Cuzco:** Prov. La Convención, Distr. Echarati, east Río Apurimac NE Pueblo Libre, up mountain of Anchihuay and Bella Vista, south Cordillera Vilcabamba, 2445 m, 3 ago 1998, *P. Núñez, W. Nauray, R. de La Colina & S. Udvardy 23484* (NY, US).

10. Schwartzia parrae Gir.-Cañas, Novon 12:456. 2002. (**Fig. 10**). TIPO: COLOMBIA. ANTIOQUIA: Mun. Yolombó, vereda El Bote, sitio Alto del Bote, 8,1 km SO de Yolombó, bosque perturbado, 75°01'O, 6°32'N, 1550 m, 1 jul 1989, *R. Callejas, J. Betancur & O. Escobar 7957* (HOLOTIPO: HUA!, ISOTIPOS: MO!, NY!).

Arbustos escandentes, tallos cilíndricos a irregularmente aplanados, fuertemente estriados; corteza castaño, ferrugínea a cobriza. Hojas subsésiles a cortamente pecioladas; pecíolo ligeramente estriado, recurvado, canaliculado (el canal muy angosto, ca. 1 mm de ancho), castaño claro a negruzco, de 2–7 mm de longitud; láminas oblongas a obovadas, de (5–)9–22 cm de longitud × (1,3–)2–5,2 cm de ancho, de base redondeada a ligeramente cordata y ápice acuminado prolongado en un apículo negruzco de 1–1,5 mm de longitud, con márgenes ligeramente revolutas o involutas y engrosadas; nervio medio conspicuo en ambas caras, levemente hundido en la haz y ligeramente abultado en el envés, liso, de 1–3 mm de ancho en la porción proximal de la lámina foliar, desvaneciéndose hacia la porción distal de la lámina foliar; venación secundaria suprimida o apenas perceptible en la haz, débil en el envés; 14–28 pares de glándulas laminales en la su-

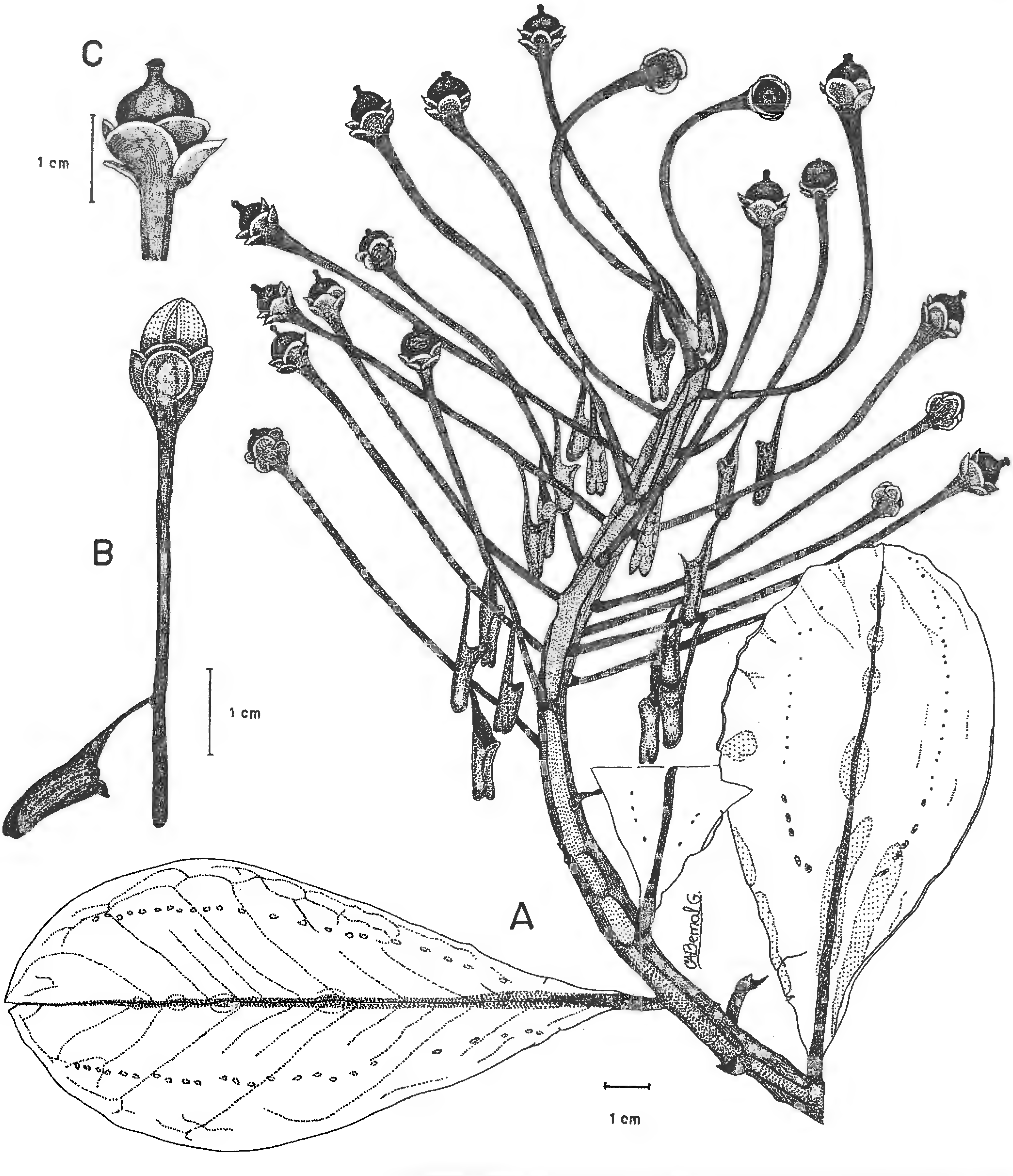


Fig. 9. ***Schwartzia magnifica*** **(Gilg) Bedell. A. Rama florífera. B. Botón floral y nectario reproductivo pedicelar. C. Fruto. (*P. Núñez et al. 23484*).**

perficie abaxial, localizadas a 1,5–11 mm de la margen, elípticas, de 1 mm de largo × 0,5 mm de ancho, con su orificio negruzco de 0,2 mm de largo × 0,15 mm de ancho, distanciadas entre sí 1–5 cm. Inflorescencia terminal, racemosa, multiflora, densa; pedúnculo de 12–19 cm de longitud; pedicelos de 4–8 cm de longitud, cilíndricos a moderadamente aplanados, rectos a levemente flexuosos, lisos a ligeramente estriados, un poco más gruesos en su porción distal, cobrizos, cada uno con una bráctea nectarífera (nectario). Nectarios reproductivos pedicelares cimbiformes, levemente rostrados, péndulos, verdes a purpúreos, ligeramente estriados longitudinalmente, pedículos de los nectarios 1,5–3 mm de longitud, urnas de (7–)9–18 mm de

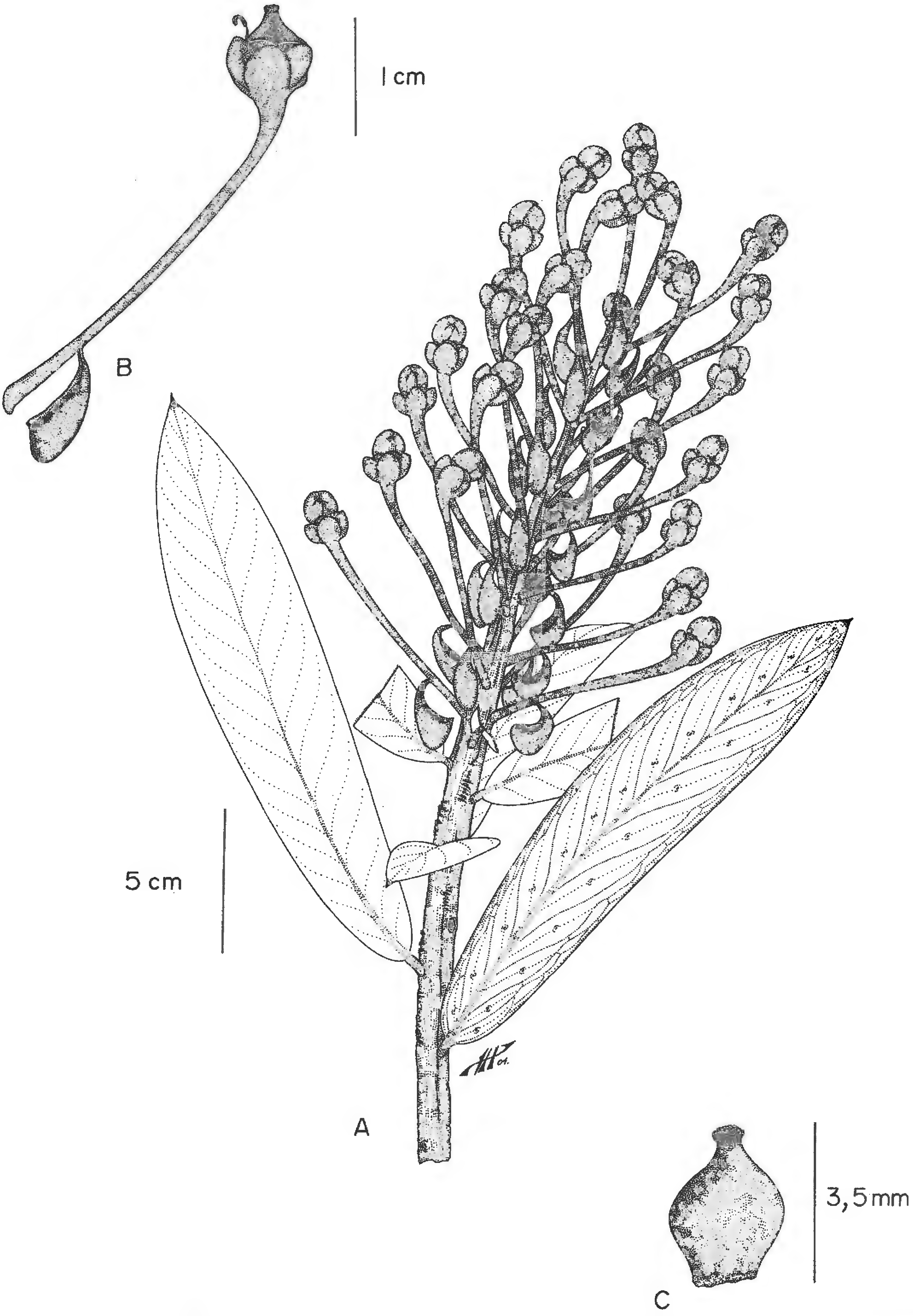


FIG. 10. *Schwartzia parrae* Gir.-Cañas. **A.** Rama florífera. **B.** Flor y nectario reproductivo pedicelar. **C.** Ovario. (*R. Callejas et al. 7957*).

longitud × (3–)4–8 mm de ancho, los orificios dispuestos hacia el eje de la inflorescencia y ocupando una posición transversal respecto a su eje, los nectarios naciendo por debajo del 1/3–1/6 proximal del pedicelo. Flores 20–32, inserción pedicelo-flor horizontal a moderadamente oblicua; bractéolas sepaloides, opuestas, orbiculares, obtusas, rugosas, carnosas, 5–7 mm de longitud, márgenes translúcidas; sépalos orbiculares, rugosos, carnosos, 7–8 mm de longitud, márgenes translúcidas; pétalos connatos basalmente (antes de la antesis) por ca. 2/3 de su longitud, obovado-elípticos, reflexos en la antesis, de 8,5–11 mm de longitud × ca. 3 mm de ancho, carnosos, rugosos; estambres 48, filamentos ca. 1,5 mm de longitud (antes de la antesis), aplanados, verruculosos, adnatos a la base de los pétalos, anteras elíptico-oblongas, subcordatas basalmente, de 3–4 mm de longitud; ovario cónico, ligeramente estriado, ca. 3,5 mm de longitud × ca. 3 mm de ancho; estigma mamiforme, subsésil, negruzco. Frutos desconocidos.

Distribución geográfica y ecología.—Esta especie sólo se conoce de la cordillera Central andina (departamento de Antioquia, Colombia) y crece entre los 1100 y los 2000 m. De esta especie sólo se poseen cuatro ejemplares colombianos, por lo que se infiere que ésta se encuentra en vías de extinción, dada la acelerada fragmentación y/o destrucción de los bosques en donde ella vive.

Especímenes examinados: **COLOMBIA. Antioquia:** Mun. Amalfi, 8–27 km NE de Amalfi, en la vía Vetilla-Fraguas, sitios Salazar y Marengo, 1150–1450 m, 7 dic 1989, *R. Callejas et al. 9102* (HUA). Mun. Guatapé, sector Santa Rita, zonas aledañas a la carretera, 75°05'O, 6°10'N, 1800–2000 m, 22 jun 1997, *F. Alzate et al. 247* (F, HUA). Mun. San Luis, vereda Manizales, finca de Ramón Jaramillo, 1460–1760 m, 11 oct 1981, *C. Orozco et al. 549* (COL).

11. Schwartzia pterosara de Roon & Bedell ex Gir.-Cañas, Novon 15:123. 2005. (**Fig. 11**). Tipo: ECUADOR. Napo: Along road between Quito and Baeza, 3 mi W of Baeza, 0°25'S, 77°51'O, 2000 m, 2 oct 1980, *T.B. Croat 50284* (holotipo: MO!; isotipos: GH, MARY).

Arbustos escandentes, epífitos, ramas subteretes con lenticelas longitudinales. Hojas cortamente pecioladas; pecíolo recurvado, canaliculado, castaño oscuro, de 3–6 mm de longitud × 2–3 mm de ancho; láminas obovadas, de (5–)8–12,5 cm de longitud × (2,2–)3,8–6,2 cm de ancho, de base aguda a cuneada y ápice obtuso a redondeado, mucronado (el mucrón ca. 1,5 mm de longitud) u ocasionalmente cuando el mucrón se ha caído entonces el ápice se ve retuso; nervio medio liso, conspicuo en ambas caras, aunque se va desvaneciendo hacia la porción distal, plano a levemente hundido o sobreelevado en la haz y ligeramente elevado en el envés; venación secundaria débil en ambas caras; 25–34 pares de glándulas laminales en la superficie abaxial, elípticas, 0,7–1,2 mm de largo × 0,5–0,8 mm de ancho, dispuestas en dos filas longitudinales en ambos extremos de la lámina, una fila submarginal ubicada a 1–7 mm de la margen, la segunda fila a 5–11 mm de la margen. Inflorescencia terminal, racemosa, multiflora, densa; pedúnculo de 10–17,2 cm de longitud; pedicelos de 3,5–5,5 cm longitud, rectos, formando con el raquis un ángulo de 45–85°, lisos a levemente estriados, cobrizos. Nectarios reproductivos pedicelares ciatiformes a ventricosos, péndulos, verdosos a rojizos, levemente estriados, pedículos de los nectarios de 3–4 mm de longitud, urnas de 6–10 mm de longitud × 6–8 mm de ancho, con el orificio dispuesto hacia el raquis; los nectarios naciendo en el cuarto o quinto inferior del pedicelo. Flores 18–42; bractéolas sepaloides, adpresas al cáliz, opuestas, elípticas a obovadas, carnosas, de (4–)8–11 mm de longitud × (4–)7–9 mm de ancho; sépalos orbiculares, carnosos, con márgenes membranáceas, de (4–)5–7 mm; pétalos libres, carnosos, elípticos a oblanceolados, de 8–11 mm de longitud × 3–5 mm de ancho; estambres 12, de 6–8 mm de longitud, filamentos aplanados, adnatos a la base de los pétalos, anteras subsagitadas, amarillentas; ovario piriforme o cónico, de 4–5 mm de longitud; estilo cilíndrico, ca. 1 mm de longitud; estigma liso, mamiforme, negruzco. Frutos globosos, apiculados, de 0,8–1,1 cm de diámetro, rojizos; semillas reniformes a elípticas, de 1,2–1,5 mm de longitud × ca. 0,7 mm de ancho, reticuladas, brillantes, numerosas.

Distribución geográfica y ecología.—*Schwartzia pterosara* sólo se conoce de los bosques andinos húmedos (ca. 2000 m) en los alrededores de Baeza en la provincia de Napo (Ecuador). No obstante, puede haber más especímenes en otros herbarios de Ecuador (e.g., QCA, QCNE, GUAY), pero desafortunadamente no tuve acceso a esas colecciones. Por otra parte, Bedell (1985) citó otro espécimen de esta especie para Colombia [*Cuatrecasas 23618* (F, US)], pero tampoco tuve acceso a este ejemplar, a pesar de que dichos herbarios

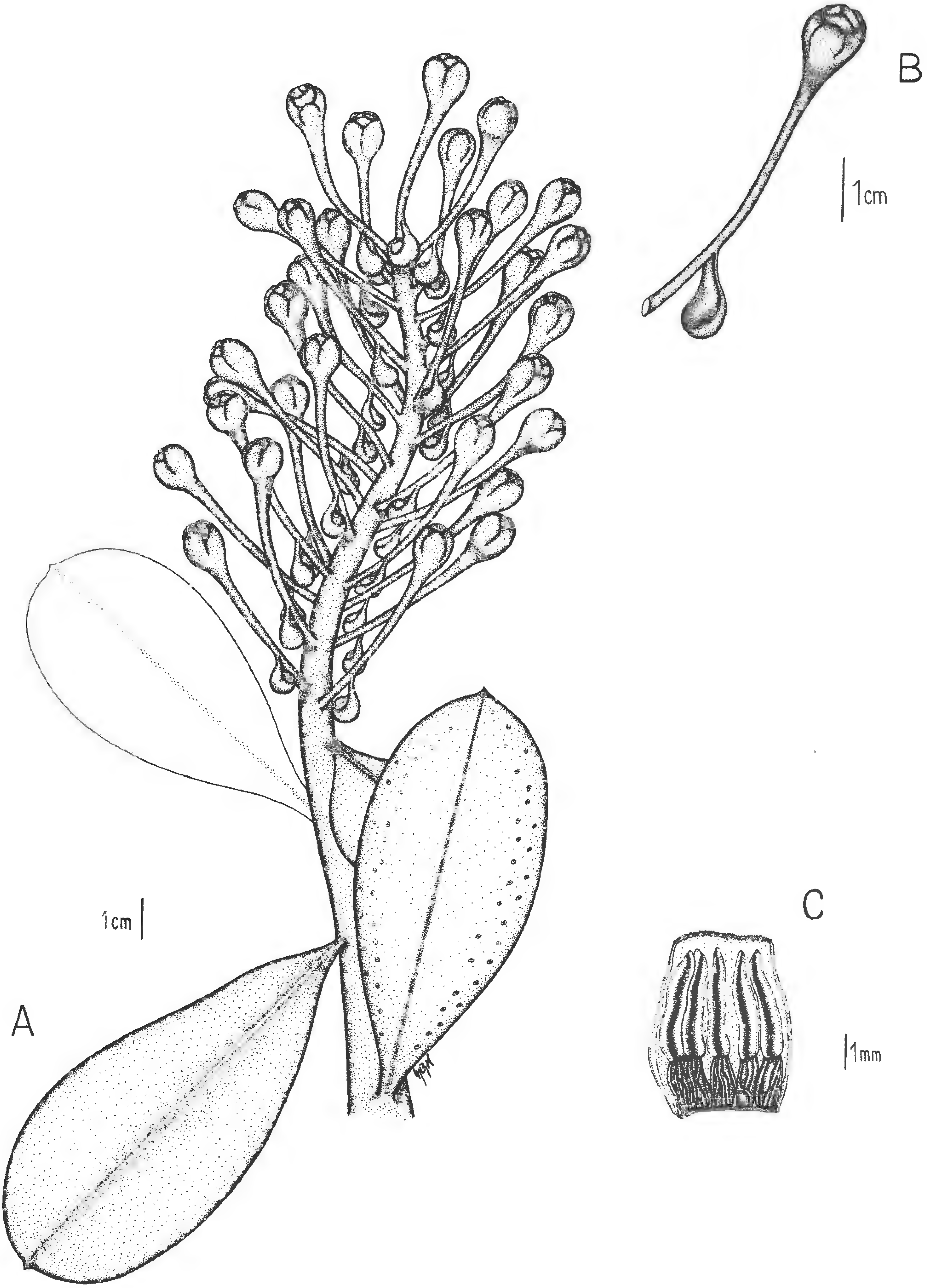


Fig. 11. *Schwartzia pterosara* de Roon & Bedell ex Gir.-Cañas. A. Rama florífera. B. Botón floral y nectario reproductivo pedicelar. C. Detalle de los estambres. (*T. Croat 50284*).

me enviaron sus colecciones, entre las que no se encontraba la mencionada por Bedell (1985). Asimismo, Stefan Dressler (FR, com. pers.) me mencionó la existencia de otros especímenes de Perú depositados en los herbarios FR y MO (*Campos & Núñez 4612*), pero desafortunadamente nunca pude verlos. Así, si estas colecciones pertenecen a *S. pterosara*, su gradiente de distribución se ampliaría significativamente.

Observaciones.—Esta especie está más relacionada con *S. magnifica*, pero también exhibe similitudes con *S. adamantium* y *S. spiciflora*. No obstante, *S. pterosara* difiere de éstas por su gran número de glándulas laminales, la densa inflorescencia y el tamaño y la forma de los nectarios reproductivos pedicelares.

Especímenes examinados: **ECUADOR. Napo.** Vicinity of Baeza, wet montane forest, 2000 m, 28–29 jun 1982, *L. Besse, H. Kennedy & R. Baker 1504* (MO).

12. Schwartzia renvoizei Gir.-Cañas, Caldasia 26:424. 2004. (**Fig. 12**). TIPO: COLOMBIA. VALLE DEL CAUCA: Cordillera Occidental, vertiente occidental, Hoya del río Sanquininí, lado izquierdo, La Laguna, bosques, 1250–1400 m, 10–20 dic 1943, *J. Cuatrecasas 15456* (HOLOTIPO: F!; ISOTIPOS: COL!, F!).

Arbusto epífito, escandente, muy ramificado, ramas decumbentes, robustas; tallo terete a subterete, rugoso, corteza escamosa, gris oscura, estriada longitudinalmente. Hojas subsésiles, pecíolos engrosados, recurvados, rugosos, castaño oscuros, hasta de 5(–6) mm de longitud y ca. 5 mm de ancho; láminas oblongo-elípticas, de 13–14 cm de longitud × 5–6 cm de ancho, de base redondeada a subcordata y ápice obtuso a redondeado, con márgenes planas o levemente revolutas; nervio medio conspicuo en ambas caras, desvaneciéndose hacia su porción distal, plano en la haz y ligeramente abultado en el envés, liso a levemente estriado; venación secundaria muy débil a suprimida en la haz, notoria aunque débil en el envés; 45–57 pares de glándulas laminales en la superficie abaxial, dispuestas en una fila más o menos regular a cada lado del nervio medio (aunque puede haber algunas glándulas dispuestas en forma aleatoria) y separadas de éste entre 5 y 10 mm, y de la margen entre 10 y 15 mm, las glándulas basales distanciadas entre sí 5–9 mm, las mediales y las distales muy próximas las unas a las otras (entre 0,5 y 1,5 mm), elípticas, levemente elevadas, ca. 0,6 mm de longitud × ca. 0,4 mm de ancho, con su orificio elíptico, ca. 0,1 mm de longitud. Inflorescencia terminal, racemosa, multiflora, densa; pedúnculo de 10–11,6 cm de longitud; pedicelos de 4–6,9 cm de longitud, levemente curvos, oblicuos con relación al eje de la inforescencia, lisos a ligeramente estriados, castaño oscuros a cobrizos. Nectarios reproductivos pedicelares galeados, robustos, péndulos, pedículos de los nectarios de 2–3,5 mm de longitud, urnas de 10–14 mm de longitud × 8–11 mm de ancho, con la boca de contorno ovado y márgenes planas a débilmente revolutas, dispuesta hacia el eje de la inflorescencia; los nectarios naciendo en el tercio inferior del pedicelo. Flores 20–26, presentando maduración basípeta, inserción pedicelo-flor horizontal a levemente oblicua; bractéolas sepaloides, opuestas, sosteniendo el cáliz, orbiculares, carnosas, de 5–6 mm; sépalos orbiculares, carnosos, de 5–7(–7,5) mm; pétalos aparentemente libres y sólo una mínima porción basal de la corola es connata, reflexos en la antesis, oblongos, carnosos, de 15–16 mm de longitud × 4–5 mm de ancho; estambres 70, filamentos *ca.* 9 mm de longitud, aplanados, anchos en la base y angostos en su ápice, lisos a levemente estriados, adnatos a la base de los pétalos y dispuestos en tres verticilos, anteras oblongas, sagitadas, amarillentas a castañas, ca. 4 mm de longitud × ca. 0,7 mm de ancho; ovario piriforme, tetra-locular, ca. 8 mm de alto, rugoso a estriado, castaño oscuro a negruzco; estigma mamiforme, negruzco. Frutos desconocidos.

Distribución geográfica y ecología.—*Schwartzia renvoizei* sólo se conoce de la localidad tipo, la que corresponde a bosques andinos premontanos de una región pluvial de la vertiente pacífica de la Cordillera Occidental en el departamento del Valle del Cauca (Colombia). En vista de que no se conocen más recolecciones de la especie y dada la acelerada deforestación de la región en donde ésta vive, se presume que la especie se encuentra en un alto riesgo de extinción.

Observaciones.—En virtud de sus ramas robustas, hojas subsésiles, venación secundaria débil a suprimida, pedúnculo corto y número de flores por inflorescencia, *S. renvoizei* podría confundirse con *S. antioquensis* y *S. chocoensis*. No obstante, *S. renvoizei* es única en el género y fácilmente reconocible por sus nectarios galeados, sus numerosos estambres y por sus numerosas glándulas laminales abaxiales. El binomio *Schwartzia micradenia* de Roon & Bedell (*in sched.*) corresponde a *S. renvoizei*.

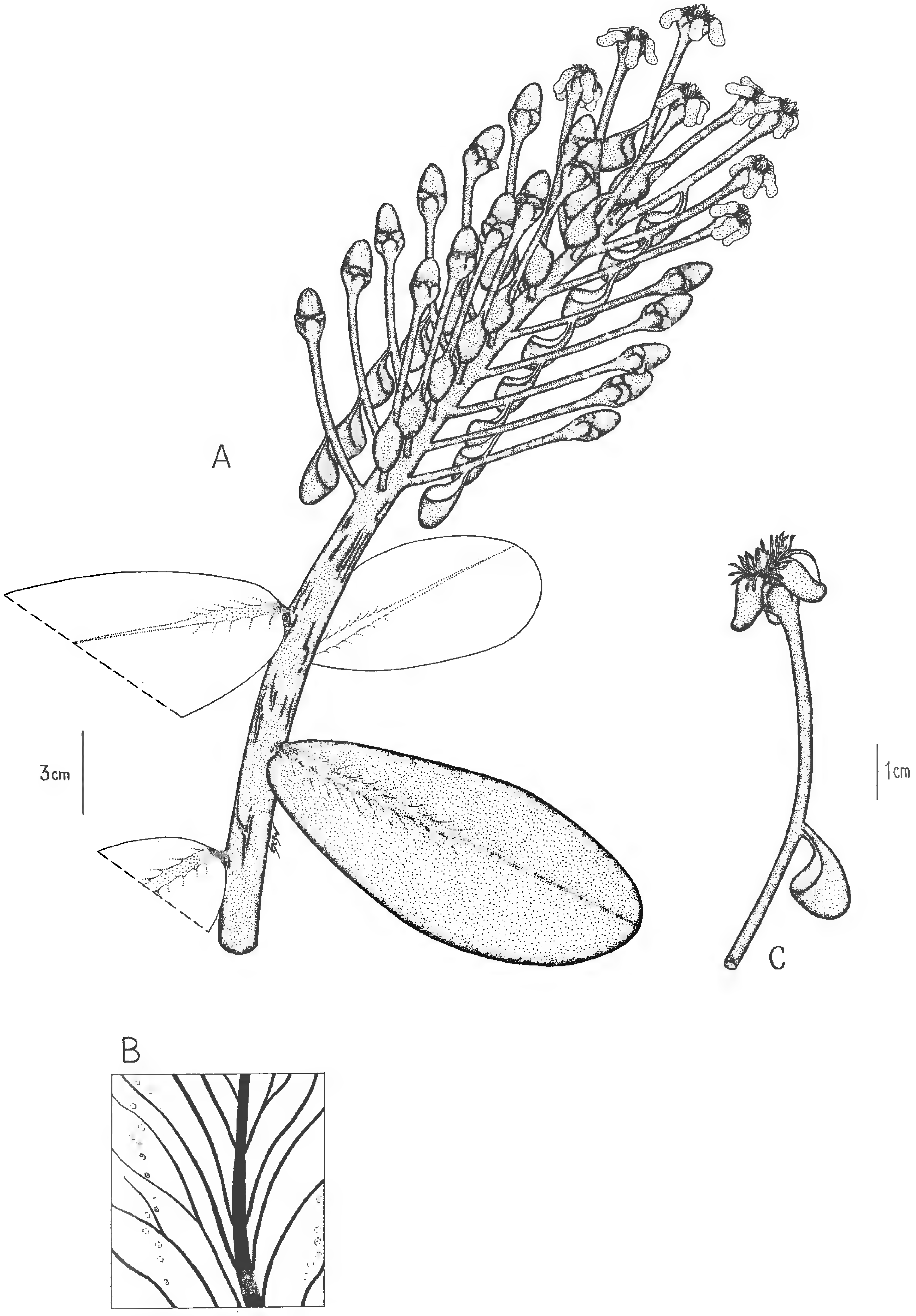


Fig. 12. *Schwartzia renvoizei* Gir.-Cañas. A. Rama florífera. B. Detalle de las glándulas abaxiales de la hoja. C. Flor y nectario reproductivo pedicelar. (*J. Cuatrecasas 15456*).

13. Schwartzia spiciflora (A.L. Juss.) Bedell, Fl. Lesser Antilles 5:309. 1989. (**Fig. 13**). *Marcgravia spiciflora* A.L. Juss., Ann. Mus. Natl. Hist. Nat. 14:402, t. 25. 1809. *Norantea spiciflora* (A.L. Juss.) Krug & Urban, Bot. Jahrb. Syst. 21:520. 1896. Tipo: GUADELOUPE: *Richard s.n.* (holotipo: P-JU; isotipos: C, P; fotografías del holotipo en F!, MO!).

Ascium berteroi Spreng., Syst. Veg. 2:599. 1825. *Norantea berteroi* (Spreng.) G. Don., Gen. Hist. 1:624. 1831. Tipo: INDIAS OCCIDENTALES: *Bertero s.n.* [holotipo: no localizado, probablemente en MEL o TO, véase Bedell (1985: 152)].

Arbustos escandentes, epífitos, lianescentes, hasta de 6 m de altura, con ramificación profusa, ramas robustas; tallos subteretes, corteza lisa a ligeramente estriada longitudinalmente, castaño a ferrugínea. Hojas cortamente pecioladas; pecíolo recurvado, canaliculado, engrosado, liso a débilmente estriado, castaño oscuro, de 2–7 mm de longitud × 2,5–4 mm de ancho; láminas obovadas u oboelípticas, de (6–)8,4–11,2 cm de longitud × (3–)4,6–5,9 cm de ancho, de base simétrica o levemente asimétrica, cuneada, ápice obtuso o agudo y en ocasiones ligeramente asimétrico, mucronado, retuso cuando se ha caído el mucrón, con las márgenes lisas o débilmente revolutas; nervio medio centrado a más comúnmente desviado, lo que hace que una de las mitades de la lámina sea más ancha que la otra, ligeramente elevado y conspicuo en ambas caras, aunque apenas perceptible en la porción distal de la lámina; venación secundaria suprimida en ambas caras o débilmente perceptible; 0–1(–2) pares de glándulas laminales en la superficie abaxial, dispuestas irregularmente, circulares, ca. 0,5 mm de diámetro. Inflorescencia terminal, racemosa, multiflora, densa; pedúnculo de (4,5–)5,5–10 cm de longitud; pedicelos de 1,6–3,5 cm de longitud (hasta 4 cm de longitud en fruto), rectos a ligeramente curvos, lisos o débilmente estriados longitudinalmente, con lenticelas o sin las mismas, castaño oscuros. Nectarios reproductivos pedicelares cimbiformes, rojizos, rugosos, con la boca dirigida hacia el eje de la inflorescencia, pedículos de los nectarios de 0–1 mm de longitud, urnas de (2,5–)3,5–5,5(–7) mm de longitud × ca. 3 mm de ancho, rostradas; los nectarios naciendo a 0,4–1,3 cm de la base del pedicelo. Flores (24–)30–52(–60); bractéolas sepaloides, suborbiculares, opuestas, sosteniendo el cáliz, de 2–3 mm de longitud; sépalos orbiculares, carnosos, de 3–3,5 mm de longitud; pétalos connatos hasta su porción media, obovado-ovales a oblongos, 6–8 mm de longitud; estambres 22, filamentos ca. 2 mm de longitud × ca. 0,5 mm de ancho (antes de la antesis), basalmente adnatos a los pétalos, aplanados, rugosos, anteras subsagitadas, ca. 2,5 mm de longitud × ca. 0,8 mm de ancho; ovario globoso a cónico, rugoso, de 2,5–4 mm de diámetro; estilo estriado a rugoso, de 1–1,5 mm de longitud; estigma mamiforme, negruzco. Frutos globosos, conspicuamente apiculados, rugosos, de 9–10,5 mm de diámetro; semillas semilunares, de 3–3,5 mm de longitud × ca. 1,5 mm de ancho, reticuladas, rugosas, negruzcas, brillantes, numerosas.

Distribución geográfica y ecología.—*Schwartzia spiciflora* es propia de bosques de montaña, tanto húmedos como nublados, caracterizados principalmente por Clusiaceae, Lecythidaceae y Podocarpaceae y crece entre los 400 y los 1500 m. Ésta está restringida a las Antillas Menores (Dominica, Guadalupe, St. Vincent y Trinidad) y al norte de la costa venezolana en el estado de Sucre.

Observaciones.—de Jussieu (1809) y Triana & Planchon (1862) comentaron que la corola de *S. spiciflora* presentaba los pétalos connatos (caliptra), lo que la acercaba al género *Marcgravia*. No obstante, las observaciones de estos autores eran erróneas y quizás se desprendan de disecciones realizadas en botones florales (y no en flores en antesis), en los que los pétalos parecen estar constituyendo una caliptra. El binomio *Norantea jussiaei* Triana & Planch. (Ann. Sci. Nat., Bot., sér. 4, 17:373. 1862) es un *nomen nudum* que corresponde a la misma *S. spiciflora*.

Especímenes examinados: **VENEZUELA. Sucre:** Península de Paria, cerro de Humo, laderas de bosque húmedo nublado que miran hacia La Roma e Irapa, entre la cumbre y La Laguna, noroeste de Irapa, 1060–1273 m, 3 mar 1966, *J. Steyermark 94954* (NY, VEN); Península de Paria, virgin cloud forest, above Las Melenas, N of Río Grande Arriba, southeast of Cerro de Humo, 730–1050 m, 1 dic 1979, *J. Steyermark & R. Liesner 120918* (MO).

14. Schwartzia weddelliana (Baill.) Bedell, Monogr. Syst. Bot. Missouri Bot. Gard. 45:1256. 1993. (**Fig. 14**). *Norantea weddelliana* Baill., Adansonia 10:242. 1872. Tipo: BOLIVIA: Yungas, *Weddell 4318* (holotipo: P; isotipo: F!, fotografía del holotipo en F!).

Marcgravia peduncularis Poepp. ex Rusby, Mem. Torrey Bot. Club 3:8. 1893. Tipo: BOLIVIA: Yungas, año 1890, *M. Bang 390* [holotipo: NY; isotipos: F! (dos ejemplares), MO!, NY! (dos ejemplares), US!], non *Norantea peduncularis* Poepp. ex Wittm. [= *Marcgraviastrum mixtum* (Triana & Planch.) Bedell].

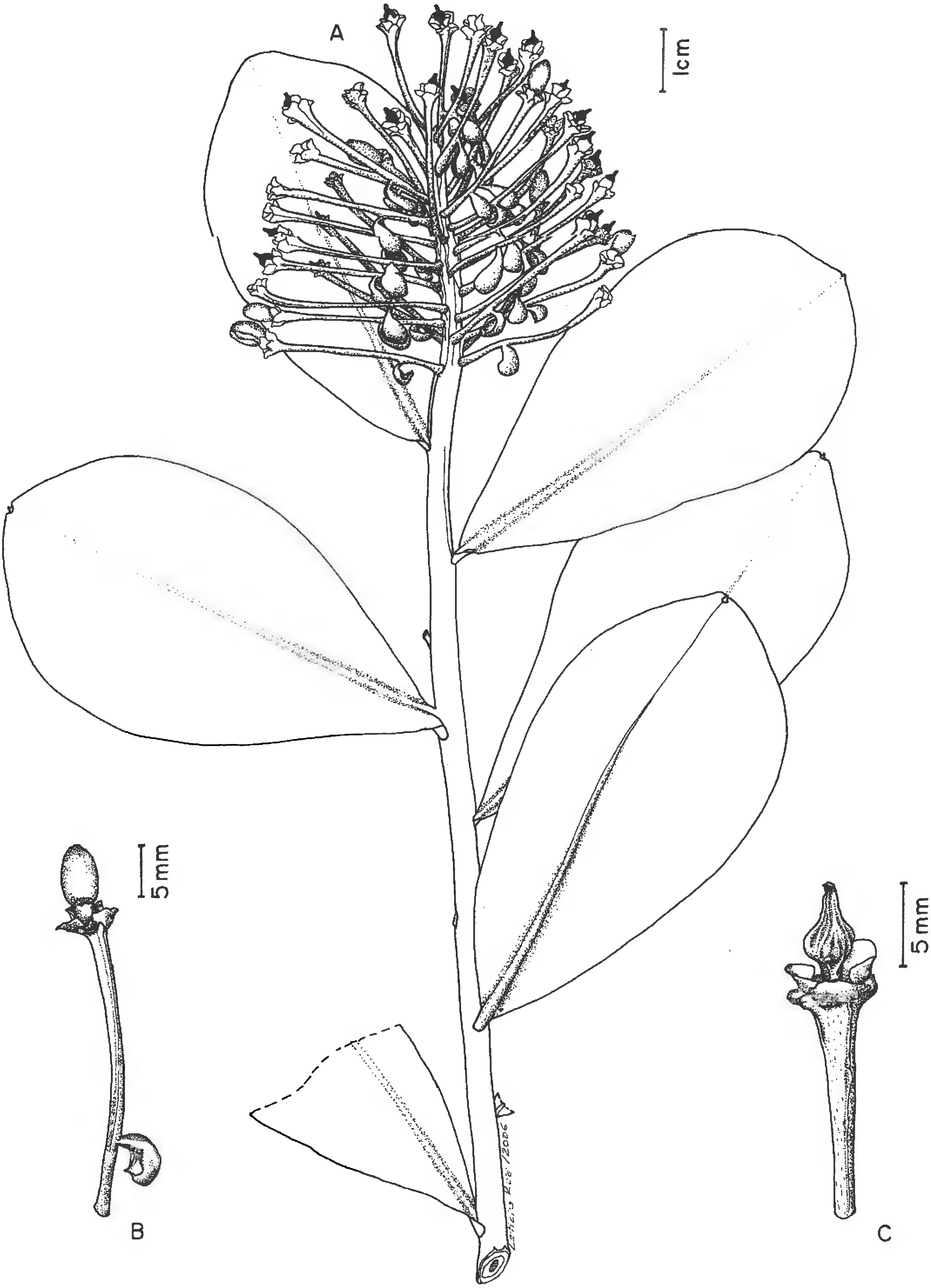


Fig. 13. *Schwartzia spiciflora* (A.L. Juss.) Bedell. A. Rama florífera. B. Botón floral y nectario reproductivo pedicelar. C. Ovario y pedicelo. (*J. Steyermark 120918*).

Norantea macrostoma Gilg, Bot. Jahrb. Syst. 25, Beibl. 60:30. 1898. Tipo: BOLIVIA: Yungas, año 1890, *M. Bang 390* [holotipo: B?; isotipos: F! (dos ejemplares), MO!, NY! (dos ejemplares), US!].

Norantea sandiensis Gilg, Bot. Jahrb. Syst. 42:126. 1908. Tipo: PERÚ. Puno: Prope Tambo Azalaya ad viam inter Sandia et Chunchusmajo in fruticetis subapertis, 1500–1600 m, *A. Weberbauer 1343* (holotipo: B; fotografías del holotipo en MO!, NY!).

Arbustos hemiepífitos, escandentes, profusamente ramificados, hasta de 4 m de altura, ramas medianamente robustas; tallos teretes a subterestes, corteza débilmente estriada longitudinalmente, castaña o ferrugínea. Hojas cortamente pecioladas; pecíolo recurvado, canaliculado, levemente estriado, castaño oscuro, de 2–8 mm de longitud × 2–3 mm de ancho; láminas obovadas o oboelípticas, ocasionalmente elípticas, de 6–12,5 cm de longitud × (3,2–)3,5–5,2(–5,8) cm de ancho, base cuneada y ápice obtuso a subagudo; nervio medio conspicuo en ambas caras, aunque más abultado en el envés, desvaneciéndose hacia su porción distal; venación secundaria suprimida en ambas caras, muy raramente apenas perceptible en la haz y/o envés; (5–)8–14(–19) pares de glándulas laminales en la superficie abaxial, dispuestas en una fila más o menos regular a ambos lados de la lámina, raramente en dos filas a ambos lados de la lámina, localizadas a 4–13 mm de la margen y distanciadas entre si 3–17 mm, circulares a elípticas, ligeramente elevadas, crateriformes, de 0,9–1,4 mm de longitud × ca. 0,8 mm de ancho. Inflorescencia terminal, racemosa, pauciflora, laxa; pedúnculo de (3–)3,5–7 cm de longitud; pedicelos de 3,5–7 cm de longitud, rectos a levemente curvos, débilmente estriados longitudinalmente, castaño oscuros a cobrizos. Nectarios reproductivos pedicelares largamente tubulares, péndulos, estriados longitudinalmente, pedículos de los nectarios de 1–7 mm de longitud, urnas de (20–)30–40(–43) mm de longitud × 3–7 mm de ancho, con la boca dispuesta hacia el eje de la inflorescencia y con las márgenes conspicuamente revolutas; los nectarios naciendo a 1,3–2,6(–3) cm de la base del pedicelo. Flores 6–10(–12); bractéolas sepaloides, orbiculares, opuestas, carnosas, sosteniendo el cáliz, de 4–5,8 mm de longitud; sépalos orbiculares, carnosos, de 6–6,8 mm de longitud; pétalos libres, obovados, carnosos, rojos, de 14–17 mm de longitud × ca. 8 mm de ancho; estambres ca. 18, filamentos ca. 7,5 mm de longitud × ca. 0,7 mm de ancho, aplanados, lisos a ligeramente estriados longitudinalmente, adnatos a la base de los pétalos, anteras ca. 4,5 mm de longitud × ca. 1 mm de ancho, subsagitadas; ovario globoso, ligeramente rugoso, ca. 4,5 mm de diámetro; estilo ca. 1 mm de longitud; estigma mamiforme. Frutos globosos, apiculados, rojos, débilmente rugosos, de 10–16 mm de diámetro; semillas falcadas, de 2,8–3,5 mm de longitud × ca. 1 mm de ancho, rugosas, castaño oscuras, brillantes, reticuladas, numerosas.

Distribución geográfica y ecología.—*Schwartzia weddelliana* es propia del sur de Perú y el norte de Bolivia, y crece en bosques húmedos maduros o secundarios, laderas pedregosas y en bosques ralos, entre los 500 y los 2000 m. Merece destacarse la cita de *S. weddelliana* (tratada como *Norantea sandiensis*) para San José del Guavire (norte de la Amazonia colombiana) realizada por Schultes (1951: 404) sobre la base del espécimen *Cuatrecasas 7685*. Desafortunadamente dicho espécimen no fue localizado en ninguno de los herbarios y por tal razón, se pone en duda la cita de la especie para Colombia.

Observaciones.—Esta especie es fácilmente reconocible por su grandes nectarios reproductivos, los cuales presentan la boca con las márgenes conspicuamente revolutas. Por otra parte, se observó en el ejemplar *Davidson 4779* (US) una variación morfológica poco usual, en la que un pedicelo distal se ramificaba en dos ejes (originando a su vez dos flores fértiles) justo en el punto de origen del nectario reproductivo.

Especímenes examinados: **BOLIVIA. La Paz:** Prov. Nor Yungas, Polo-Polo bei Coroico, 1100 m, oct–nov 1912, *O. Buchtien 6020* (US). Prov. Nor Yungas, carretera fundamental 3, between Coroica (Yolosa) and Caranavi, road parallel to Río Coroico, 700–1300 m, 6 nov 1976, *C. Davidson 4779* (MO, NY, RSA-dos ejemplares-, US). Prov. Nor Yungas, below San Pedro, Yolosa-Caranavi road, valley of Río Coroico, 760–950 m, 15 ene 1984, *A. Gentry et al. 44215* (MO). Prov. Nor Yungas, 4.5 km below Yolosa, then 10 km W on road up the Río Huarinilla, 1450 m, 19–20 oct 1982, *J. Solomon 8526* (MO, NY). Prov. Nor Yungas, 4.5 km below Yolosa, then 14 km W on road up Río Huarinilla, along old, abandoned road to Hacienda Sandillani, on south side of river, 1200–1300 m, 24 ene 1983, *J. Solomon 9370* (MO). Prov. Nor Yungas, 10.2 km SW of Yolosa on road to Chuspipata, 20 km NE of Chuspipata, 1700 m, 5 abr 1984, *J. Solomon & M. Uehling 12250* (MO, NY, SI); Yungas, ca. 2000 m, año 1885, *H. Rusby 1362* (NY, dos ejemplares); Sin localidad: ca. 500 m, jun 1886, *H. Rusby 2707* (NY). **Santa Cruz:** Prov. Ichilo, cerro Amboro, 23 sep 1990, *M. Lewis & R. Clark 37736* (SI). **PERÚ. Cuzco:** Prov. La Convención, 139 km de Cuzco en Quellomayo, subiendo hacia la "ceja", entre Santa Teresa y Chaullay, 1–3 ene 1988, *P. Núñez & F. Motocanchi 8811* (MO, NY). Prov. La Convención, Hisadquiña, km 127.5, 1700 m, 13–14 sep 1962, *C. Vargas 13917* (US). Prov. La Convención, Colca, 1300 m, sin fecha, *C. Vargas 20790* (NY). **Junín:** 38.1 km NE of Tarma on Carretera 20-B to Oxapampa, above Río Placa, ca. 2250 m, 13

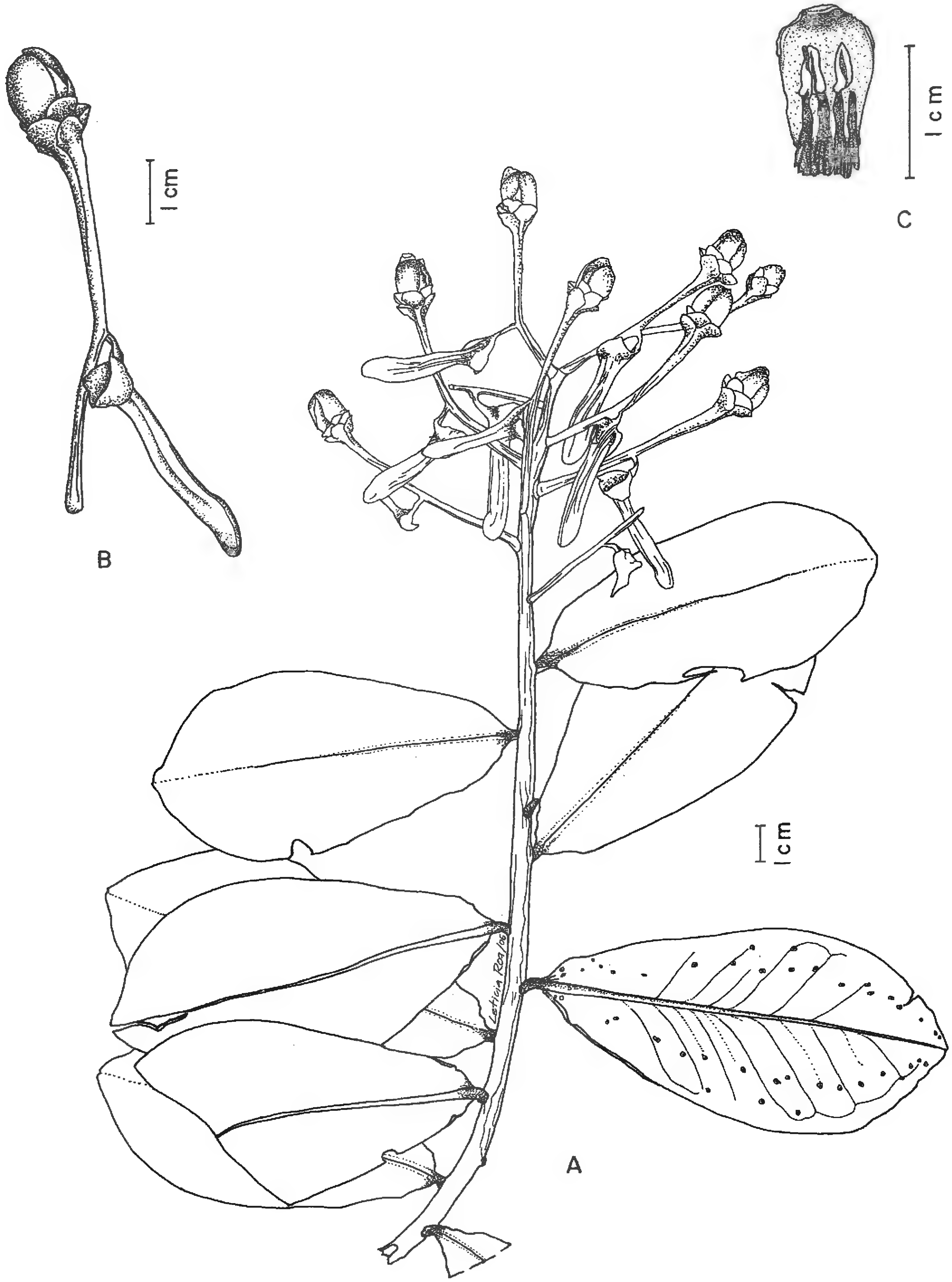

1 cm
C
1 cm
B
1 cm
Leticia Roa /06
A

Fig. 14. *Schwartzia weddelliana* (Baill.) Bedell. A. Rama florífera. B. Botón floral y nectario reproductivo pedicelar. C. Detalle de los estambres. (*J. C. Solomon 8526*).

nov 1979, *J. Jones 9090* (RSA, dos ejemplares); 26.3 km NE of Central Plaza in Acobamba (NE of Tarma) on Carretera 20-B to Oxapampa, ca. 2000 m, 14 nov 1979, *J. Jones 9149* (RSA).

EJEMPLARES EXCLUIDOS Y REGISTROS DUDOSOS

Bedell (1985) citó un espécimen del departamento del Cauca (Colombia) y lo asignó a la especie *Schwartzia pterosara* [*Cuatrecasas 23618* (F, US)]. No obstante y a pesar de disponer de los préstamos de Marcgraviaceae de estos dos herbarios, dicha colección no se pudo localizar.

Como dato curioso, merece destacarse la cita de *Schwartzia weddelliana* (tratada como *Norantea sandiensis*) para San José del Guavire (norte de la Amazonia colombiana) realizada por Schultes (1951: 404) sobre la base del espécimen *Cuatrecasas 7685*. Desafortunadamente dicho ejemplar no fue localizado en ninguno de los herbarios y por tal razón, se pone en duda la cita de la especie para Colombia. Del mismo modo, *S. weddelliana* fue citada para Brasil por Szyszylowicz (1893: 163) (como *Norantea weddelliana* Baill.), pero realmente ésta sólo se distribuye en el sur de Perú y el norte de Bolivia.

ESPECIES EXCLUIDAS

Schwartzia colombiana de Roon & Bedell = **Pseudosarcopera diaz-piedrahitae** (Gir.-Cañas) Gir.-Cañas
Schwartzia diaz-piedrahitae Gir.-Cañas = **Pseudosarcopera diaz-piedrahitae** (Gir.-Cañas) Gir.-Cañas

LISTA DE LOS SINÓNIMOS DE LAS ESPECIES SUDAMERICANAS DE *SCHWARTZIA*:

los binomios de la derecha son los nombres actualmente aceptados.

Ascium adamantium Steud. = **Schwartzia adamantium** (Cambess.) Bedell ex Gir.-Cañas
Ascium berteroi Spreng. = **Schwartzia spiciflora** (A. L. Juss.) Bedell
Ascium selloi Spreng. = **Schwartzia brasiliensis** (Choisy) Bedell ex Gir.-Cañas
Marcgravia peduncularis Poepp. ex Rusby = **Schwartzia weddelliana** (Baill.) Bedell
Marcgravia spiciflora A.L. Juss. = **Schwartzia spiciflora** (A.L. Juss.) Bedell
Norantea adamantium Cambess. = **Schwartzia adamantium** (Cambess.) Bedell ex Gir.-Cañas
Norantea bahiensis Mart. ex Wittm. = **Schwartzia brasiliensis** (Choisy) Bedell ex Gir.-Cañas
Norantea berteroi (Spreng.) G. Don = **Schwartzia spiciflora** (A.L. Juss.) Bedell
Norantea brasiliensis Choisy = **Schwartzia brasiliensis** (Choisy) Bedell ex Gir.-Cañas
Norantea jussiaei Triana & Planch. = **Schwartzia spiciflora** (A.L. Juss.) Bedell
Norantea macrostoma Gilg = **Schwartzia weddelliana** (Baill.) Bedell
Norantea magnifica Gilg = **Schwartzia magnifica** (Gilg) Bedell
Norantea sandiensis Gilg = **Schwartzia weddelliana** (Baill.) Bedell
Norantea selloi (Spreng.) G. Don = **Schwartzia brasiliensis** (Choisy) Bedell ex Gir.-Cañas
Norantea spiciflora (A.L. Juss.) Krug & Urban = **Schwartzia spiciflora** (A.L. Juss.) Bedell
Norantea thyrsiflora Gilg = **Schwartzia magnifica** (Gilg) Bedell
Norantea weddelliana Baill. = **Schwartzia weddelliana** (Baill.) Bedell
Schwartzia foreroi de Roon & Bedell = **Schwartzia chocoensis** Gir.-Cañas
Schwartzia glabra Vell. = **Schwartzia brasiliensis** (Choisy) Bedell ex Gir.-Cañas
Schwartzia micradenia de Roon & Bedell = **Schwartzia renvoizei** Gir.-Cañas
Schwartzia venusta Bedell = **Schwartzia lozaniana** Gir.-Cañas
Schwartzia venusta de Roon & Bedell = **Schwartzia lozaniana** Gir.-Cañas

AGRADECIMIENTOS

Quiero manifestar mi profundo reconocimiento al Instituto de Ciencias Naturales de la Universidad Nacional de Colombia por todas las facilidades que me brindó para la preparación de este trabajo. A los curadores de los herbarios CEPEC, CHOCO, COAH, COL, CR, CUVC, HUA, F, IBGE, JAUM, MEDEL, MEXU, MO, MOL, MPU, NY, PSO, RSA, SI, SP, UDBC, UIS, US y VEN por los préstamos enviados o por su grata colaboración durante la visita a sus instalaciones. A Stefan Dressler (FR) y Adrian de Roon (U) por su valiosa ayuda y por sus acertados comentarios y correcciones. Asimismo, a Peter A. Schäfer del Institut de Botanique - Université Montpellier (herbario MPU) por su valiosa información acerca de material tipo depositado en MPU. A Rosa Ortiz-Gentry (MO), Olga Martha Montiel (MO), Victoria Hollowell (MO), Carlos Parra (COL), Enrique Forero (COL), Paul M. Peterson (US), Orlando Rivera (COL), Orlando Rangel (COL) y Travis Columbus (RSA) por su valiosa colaboración. A Stefan Dressler (FR) y Álvaro Idárraga (HUA) por el obsequio de valiosa bibliografía. A los herbarios de los jardines botánicos Rancho Santa Ana "RSA" (Claremont, California, EE.UU) y Missouri "MO" (St. Louis, Missouri, EE.UU), así como al "Smithsonian Institution-National Herbarium" (Washington D.C., EE.UU) por las facilidades económicas brindadas para las visitas a sus instalaciones. A Dubán Canal y Henry Arellano por la elaboración de las ilustraciones. A Barney Lipscomb por su valiosa colaboración y amable ayuda para llevar a feliz término esta publicación.

REFERENCIAS

Arruda, R., J. Cabrelli Salles & P.E. de Oliveira. 2007. Hummingbird pollination in *Schwartzia adamantium* (Marcgraviaceae) in an area of Brazilian Savanna. Rev. Brasil. Zoociências 9(2):193–198.

Bedell, H. 1985. A generic revision of Marcgraviaceae I. The *Norantea* complex. Ph.D. Dissertation, University of Maryland, College Park.

Bedell, H. 1989. Marcgraviaceae. En: R. Howard, ed. Fl. Lesser Antilles 5:300–310.

Cocucci, A. 1980. Precisiones sobre la terminología sexológica aplicada a angiospermas. Bol. Soc. Argent. Bot. 19:75–81.

Cronquist, A. 1981. An integrated system of classification of flowering plants. Columbia Univ. Press, New York.

de Jussieu, M. 1809. Mémoire sur une nouvelle espèce de *Marcgravia*, et sur les affinités botaniques de ce genre. Ann. Mus. Natl. Hist. Nat. 14:397–411.

de Roon, A. C. 1970. Marcgraviaceae. En: R. Woodson & R. Schery, eds. Fl. Panama. Ann. Missouri Bot. Gard. 57:29–50.

de Roon, A.C. 1975. Contributions towards a monograph of the Marcgraviaceae. Tesis Doctoral, Universidad de Utrecht, Utrecht.

Dressler, S. 2001. Marcgraviaceae. En: J. Steyermark, P. Berry & B. Holst, eds. Fl. Venezuelan Guayana 6:248–260.

Dressler, S. 2004a. Marcgraviaceae. En: N. Smith, S. Mori, A. Henderson, D. Stevenson, & S. Heald, eds. Flowering plants of the Neotropics. Princenton University Press, Princenton, NJ. Pp. 236–239.

Dressler, S. 2004b. Marcgraviaceae. En: K. Kubizki (ed.), The families and genera of vascular plants. VI. Flowering plants-Dicotyledons, Celastrales, Oxalidales, Rosales, Cornales, Ericales. Springer, Berlín. Pp. 258–265.

Ferreira, G. 1982. Anatomía foliar de *Norantea brasiliensis* Choisy (Marcgraviaceae). Arq. Jard. Bot. Rio de Janeiro 26:87–94.

Ferreira, G. 1995. Estudo taxonômico das espécies brasileiras do gênero *Norantea* Aublet (Marcgraviaceae). Arq. Jard. Bot. Rio de Janeiro 33:9–53.

Font Quer, P. 1993. Diccionario de Botánica. Ed. Labor, S.A., Barcelona.

Gentry, A. 1991. Breeding and dispersal systems of lianas. En: F. Putz & H. Mooney, eds. The biology of vines. Cambridge University Press, Cambridge, UK. Pp. 393–423.

Gentry, A. 1993. A field guide to the families and genera of woody plants of northwest South America (Colombia, Ecuador, Peru), with supplementary notes on herbaceous taxa. Conservation International, Washington D.C.

Gilg, E. & E. Werdermann. 1925. Marcgraviaceae. En: A. Engler & K. Prantl, eds. Nat. Pflanzenfam., ed. 2, 21:94–106.

Giraldo-Cañas, D. 1999. Las Marcgraviaceae de la Amazonia colombiana: estudio preliminar sobre su diversidad, distribución y fitogeografía. Darwiniana 37:15–24.

Giraldo-Cañas, D. 2003. Revisión de las especies colombianas del género *Schwartzia* (Marcgraviaceae). Caldasia 25:1–21.

Giraldo-Cañas, D. 2005. Validation of a new species of *Schwartzia* (Marcgraviaceae) and synopsis of the genus for Ecuador. Novon 15:123–127.

Giraldo-Cañas, D. 2006. Lectotipificación para *Schwartzia magnifica* (Complejo *Norantea*, Marcgraviaceae) y revisión del género para Bolivia y Perú. Caldasia 28:275–283.

Giraldo-Cañas, D. 2007. Un nuevo género de la familia neotropical Marcgraviaceae (Ericales) y circunscripción del complejo *Norantea*. Caldasia 29:203–217.

Giraldo-Cañas, D. 2008. Las especies mesoamericanas y caribeñas del género *Schwartzia* (Complejo *Norantea*, Marcgraviaceae). Rev. Inst. Univ. Tecnológica Chocó 27:4–18.

Giraldo-Cañas, D. & P. Fiaschi. 2005. Las Marcgraviaceae (Ericales) de Brasil: Las especies del complejo *Norantea*. Caldasia 27:173–194.

Holmgren, P., N. Holmgren & L. Barnett. 1990. Index herbariorum. Part I: the herbaria of the World. The New York Botanical Garden, Bronx.

Kiesling, R. 2002. Código Internacional de Nomenclatura Botánica (Código de Saint Louis). Edición en español, Instituto de Botánica Darwinion-Missouri Botanical Garden, Buenos Aires.

Kummrow, R. 1977. Marcgraviáceas do Estado do Paraná. Bol. Mus. Bot. Municipal Curitiba 31:1–7.

León, B. & Ch. Monsalve. 2006. Marcgraviaceae endémicas del Perú. El libro rojo de las plantas endémicas del Perú, número especial. Rev. Peru. Biol. 13:426s–427s.

Macbride, J. 1956. Marcgraviaceae, Flora of Peru. Field Museum of Natural History, Bot., part III–A, 13:703–717.

Peixoto, A. 1985. Marcgraviaceae. En: J. Rizzo, ed. Flora do Estado de Goiás, Coleção Rizzo. Pp. 5:1–32.

Pinheiro, M., W. Texeira Ormond, H. Alves de Lima & M. Rodrigues Correia. 1995. Biologia da reprodução de *Norantea brasiliensis* Choisy (Marcgraviaceae). Rev. Brasil. Biol. 55 (supl. 1):79–88.

Punt, W. 1971. Pollen morphology of the genera *Norantea*, *Souroubea*, and *Ruyschia* (Marcgraviaceae). Pollen & Spores 13:199–232.

Reitz, R. 1968. Marcgraviáceas. En: R. Reitz, ed. Fl. Ilustrada Catarinense, I parte, fascículo Marc.: 1–12.

Sazima, I., S. Buzato & M. Sazima. 1993. The bizarre inflorescence of *Norantea brasiliensis* (Marcgraviaceae): visits of hovering and perching birds. Bot. Acta 106:507–513.

Schmid, R. 1988. Reproductive versus extra-reproductive nectaries: Historical perspective and terminological recommendations. Bot. Rev. 54:179–232.

Schultes, R. 1951. Contribución al conocimiento de la flora amazónica de Colombia, I. Rev. Acad. Colomb. Ci. Exact. 8(31):397–408.

Szyszylowicz, I. 1893. Marcgraviaceae. En: A. Engler & K. Prantl, eds. Nat. Pflanzenfam. 3(6):157–164.

Triana, J. & J. Planchon. 1862. Prodromus floræ Novo-Granatensis: Ternstroemiaceae trib. I. Marcgravieae. Ann. Sci. Nat. Bot., sér. 4, 17:359–379.

Vasconcellio Souza, A. 1881. Floræ Fluminensis, seu descriptionum plantarum præfectura. Rio de Janeiro.

Vellozo, J. 1825 [1829]. *Schwartzia*. Fl. Flumin. 5:221–222.

Ward, N. & R. Price. 2002. Phylogenetic relationships of Marcgraviaceae: Insights from three chloroplast genes. Syst. Bot. 27:149–160.

Weberling, F. 1992. Morphology of flowers and inflorescences. Cambridge University Press, New York.

Wittmack, L. 1878. Marcgraviaceae. En: C. F. P. von Martius, ed. Fl. Brasil. 12:213–258.

BOOK REVIEW

Judy Barrett. 2009. **What Can I Do With My Herbs? How to Grow, Use & Enjoy These Versatile Plants.** (ISBN 978-1-60344-092-9, flexbound with flaps). Texas A&M University Press, John H. Lindsey Building, 4354 TAMU, College Station, Texas 77843-4354, U.S.A. (**Orders:** www.tamu.edu/upress, 1-800-826-8911). $19.95, 134 pp., 40 color paintings, index, 6 3/8" × 8 3/4".

Forty different herbs are celebrated and explored in this informative and easy-to-read book. The chapters are broken up into sections headed by active suggestions, most commonly "Learn about it," "Grow it," "Deter with it," "Soothe with it," "Eat it," and "Dry it".

The sections give basic information related to each suggestion, and the reader gets a well-rounded idea of each herb in about two to four pages. The author injects some humorous and interesting tidbits throughout the book, handily spicing up the otherwise general information about growing and using herbs. For example, the chapter on Horseradish has a section entitled "Get pretty with it", which describes using this herb to create a clarifying skin lotion. Catnip, of course, has a section to "Thrill cats with it." Geraniums, the author relays, add bulk, fiber, and scent in paper-making. A couple of the chapters also contain one or more caution statements warning against such dangers as ingestion or skin contact related to that particular herb.

While the information in this book may be nothing new to herbal experts, it is a great overview for the amateur looking to increase and utilize the home herb garden.—*Tracie Harris, Volunteer, Botanical Research Institute of Texas, Fort Worth, Texas 76102-4025, U.S.A.*

J. Bot. Res. Inst. Texas 3(2): 726. 2009

AGAIN: TAXONOMY OF YELLOW-FLOWERED CAULESCENT *OXALIS* (OXALIDACEAE) IN EASTERN NORTH AMERICA

Guy L. Nesom

2925 Hartwood Drive
Fort Worth, Texas 76109, U.S.A.
guynesom@sbcglobal.net

ABSTRACT

The taxonomy of *Oxalis* sect. *Corniculatae* is revised for eastern North America and contrasted with previous classifications and circumscriptions, particularly those of Eiten and Lourteig. Eight taxa, some previously recognized as subspecies or varieties, are recognized here at species rank. *Oxalis stricta* L. and *O. dillenii* Jacq. sensu stricto are appropriately identified in the sense that Eiten used the names. *Oxalis florida* Salisb. (= *O. dillenii* subsp. *filipes*) is a distinct species primarily of the Atlantic states and Gulf coast, less common in more inland regions. *Oxalis priceae* Small is a distinct species of the southeastern USA without infraspecific taxa; disjunct populations occur in northeastern Mexico. *Oxalis texana* (Small) Fedde (= *Oxalis priceae* subsp. *texana*) is treated as a distinct species of east Texas and adjacent Louisiana and Arkansas. *Oxalis texana* is close in morphology to *O. dillenii* sensu stricto and occurs sympatrically with it but distinct in geography and morphology from *O. priceae* sensu stricto. *Oxalis illinoensis* Schwegm. is geographically and morphologically distinct from *O. grandis* Small. Neotypes are designated for *O. lyonii* and *O. illinoensis*.

RESUMEN

Se revisa la taxonomía de *Oxalis* sect. *Corniculatae* en el este de Norte América y se contrasta con clasificaciones previas y circunscripciones, particularmente las de Eiten y Lourteig. Ocho taxa, algunos reconocidos previamente como subespecies o variedades, se reconocen aquí en el rango específico. *Oxalis stricta* L. y *O. dillenii* Jacq. sensu stricto se identifican apropiadamente en el sentido en que Eiten usó los nombres. *Oxalis florida* Salisb. (= *O. dillenii* subsp. *filipes*) es una especie distinta primariamente de los estados atlánticos y la costa del Golfo, menos común en las regiones más interiores. *Oxalis priceae* Small es una especie del sureste de USA sin taxa infraespecíficos; con poblaciones disyuntas en el noreste de México. *Oxalis texana* (Small) Fedde (= *Oxalis priceae* subsp. *texana*) se trata aquí como una especie distinta del este de Texas junto con las adyacentes Louisiana y Arkansas. *Oxalis texana* está próxima en la morfología a *O. dillenii* sensu stricto y ocurre simpátricamente con ella pero distinta en geografía y morfología de *O. priceae* sensu stricto. *Oxalis illinoensis* Schwegm. es geográfica y morfológicamente distinta de *O. grandis* Small. Se designan neotipos para *O. lyonii* y *O. illinoensis*.

Yellow-flowered caulescent *Oxalis* (sect. *Corniculatae*) of North America has been the object of interest and study for more than a century. Small (1898, 1903, 1907) described a number of new taxa and brought the names into wide usage; he also treated sect. *Corniculatae* as a separate genus, *Xanthoxalis* Small. Wiegand (1925) provided a detailed and formal overview of the group and recognized many minor variants with formal names, with an emphasis of study on northern North America. Eiten's (1955, 1963) studies distilled the taxonomy to a set of more realistic taxa based on biological concepts rather than typological ones. Lourteig (1979) restudied the group and applied a very different set of names to the taxa, differing in part in the selection of types and in part in concepts of relationships and taxonomic ranks. Useful perspectives on problems of typification and nomenclature have been provided by Watson (1989) and Ward (2004), as noted below. Still, significant problems in identification have remained and confusion persists about which names are appropriate. In restudying, again, the eastern North American plants toward development of a treatment of Oxalidaceae for the Flora of North America series, I have come to a still different view, although it is far closer to Eiten's than Lourteig's. In fact, Lourteig's biology and nomenclature appears to have been retrograde in many ways compared to Eiten's.

In the taxonomic summaries below, synonymy is representative, showing the more commonly used names and some that allude to aspects of variability within the species. Additional synonymy can be found in Eiten (1955), Lourteig (1979), and Watson (1989). Closely related taxa of the western USA are *Oxalis californica* (Abrams) R. Knuth, *O. albicans* Kunth, *O. pilosa* Nutt. ex Torr. & Gray, and *O. suksdorfii* Trel.—these

J. Bot. Res. Inst. Texas 3(2): 727 – 738. 2009

also have been treated in various taxonomic arrangements (e.g., Wiegand 1925; Lourteig 1979; Turner 1994). Useful illustrations are provided by Young (1958) and Eiten (1963).

In the present study, species are understood as taxa morphologically intergrading little or not at all with other taxa—sympatry of such taxa is taken as evidence of their reproductive isolation. With further study, beyond the scope of this overview, complexities in reproductive biology probably will show the taxonomic framework advanced here to be overly simplistic. In *Oxalis corniculata* and *O. dillenii*, populations of odd-polyploid, even-polyploid, and dysploid chromosome numbers have been reported; polyploid populations are reported in *O. stricta*. Eiten's study (1963) suggested that essentially homostylous species (*O. corniculata*, *O. dillenii*, *O. florida*, *O. stricta*) are pseudogamous apomicts when self-pollinated—pollination and pollen tube growth resulting only in endosperm fertilization. Among these, at least *O. florida* appears to be a facultative apomict—emasculated flowers producing abundant apomictic seeds and also producing sexual seeds when pollinated with acceptable pollen (Lovett Doust et al. 1981). Sexual seed production from outcrossing may occur in the other species as well. Species with strong morphological heterostyly (e.g., *O. grandis*, *O. priceae*) are consistently outcrossers. Artificial hybrids are easily produced and natural hybrids in various combinations have been identified by Eiten (1963).

The present study is based on examination of a conservatively estimated 2400 specimens (see Acknowledgements for herbaria consulted). Both Eiten and Lourteig annotated many specimens among those studied here, especially at GH, SMU, and TEX-LL, so the current author is familiar in detail with their concepts of the taxa involved. In 2009, the author has studied natural populations of sect. *Corniculatae* in Arkansas, Louisiana, Massachusetts, Missouri, Oklahoma, and Texas.

KEY TO THE YELLOW-FLOWERED CAULESCENT *OXALIS* SPECIES OF EASTERN NORTH AMERICA

1. Stems evenly strigose from base to peduncles and pedicels.
  2. Flowers 1 or 2–3(–5, rarely to 8) in umbelliform cymes, homostylous; petals 5–11 mm long, completely yellow, without red lines ____ **2. Oxalis dillenii**
  2. Flowers (2–)3–5(–8) in umbelliform cymes, distylous; petals (10–)12–16(–17) mm long, yellow, with prominent red stripes at the base (corolla throat) ____ **4. Oxalis texana**
1. Stems pilose to villous to nearly glabrous, rarely strigose and then only on peduncles or pedicels.
  3. Petals 10–20 mm long, yellow with prominent red stripes at the base (corolla throat).
    4. Stems densely and pilose with stiffly spreading nonseptate hairs; stoloniform rhizomes numerous on an individual plant and lignescent or ligneous; flowers 1 or (2–)3–8 in umbelliform cymes above the level of the leaves; corolla throats prominently red-lined within; petals 14–20 mm long ____ **3. Oxalis priceae**
    4. Stems nearly glabrous to sparsely or densely pilose or villous with septate hairs or a mixture of septate and nonseptate hairs; stoloniform rhizomes usually 1 or few, herbaceous or lignescent; flowers 1 or 2–4(–8) in regular or irregular cymes, above or within the level of the leaves; corolla throats yellow, very faintly to strongly red-lined within; petals 10–18 mm long.
      5. Plants arising from slender, lignescent, stoloniform rhizomes without tubers; leaflets with upper shoulders usually rounded, margins often with a narrow purple margin; flowers produced above the level of the leaves; petals 10–14 mm long, throat yellow to very faintly or weakly red-lined within ____ **7. Oxalis grandis**
      5. Plants arising from slender, herbaceous, stoloniform rhizomes at intervals producing white, horizontal, fusiform tubers or tuberlike thickenings; leaflets with upper shoulders flattened, margins green; flowers produced mostly within the level of the leaves; petals 12–18 mm long, throat strongly red-lined within ____ **8. Oxalis illinoensis**
  3. Petals 4–9(–11) mm long, yellow, without red lines.
    6. Stems repent and radiating from taproot, rooting at most nodes; seeds brown, transverse ridges not white; stipules oblong with free marginal flanges and free distal auricles ____ **1. Oxalis corniculata**
    6. Stems erect, usually arising singly from the base, rarely leaning and decumbent, not rooting at the nodes or rarely so; seeds all brown or with white transverse ridges; stipules obsolescent or reduced and without free margins or distal auricles.
      7. Stems 20–60(–90) cm long, sparsely to very sparsely pilose with nonseptate hairs or a mixture of nonseptate and septate hairs or densely villous with septate hairs, arising singly from the base from a short herbaceous to lignescent rhizome; flowers usually (3–)5–7(–15) in regular (rarely irregular) cymes; capsules villous to puberulent and villous to glabrate ____ **6. Oxalis stricta**

7. Stems (5–)8–30(–35) cm, sparsely pilose with nonseptate hairs to almost completely glabrous, arising from a taproot, often producing lignescent stolons; flowers 1 or 2(–3, rarely 4–5) in umbelliform cymes; capsules glabrous to sparsely puberulent, not villous ________ **5. Oxalis florida**

1. Oxalis corniculata L., Sp. Pl. 1:435. 1753. *Xanthoxalis corniculata* (L.) Small, Fl. S.E. U.S. 667. 1903. Type: ITALY: From a wild source in Florence ("Florentia spunti," as recorded by Burser)," Herb. Burser XVIII(2), fol. 60 (UPS-BURSER) (lectotype, Watson 1989; see Jarvis 2007: Photo in Watson 1989, p. 357, Fig. 7). The protologue notes "Habitat in Italia, Sicilia."

Oxalis corniculata var. *atropurpurea* Planch. in Van Houtte, Fl. Serres Jard. Eur. 12:47, pl. 1205. 1857. Type: Lourteig 1979, pl. 205 in Van Houtte (1857).

Oxalis corniculata var. *langloisii* (Small) Wieg., Rhodora 27:121. 1925. *Oxalis langloisii* (Small) Fedde, Just's Bot. Jahresber. 32:410. 1905. *Xanthoxalis langloisii* Small, Fl. S.E. U.S. 667, 1332. 1903. Type: U.S.A. Louisiana. St. Martin Par.: near St. Martinsville, in low woods, 15 Mar 1897, *A.B. Langlois s.n.* (holotype: NY, NY digital image!).

Oxalis corniculata var. *repens* (Thunb.) Zucc., Denkschr. Koeingl. Akad. Wiss. München, ser. 2, 1:230. 1831. *Oxalis repens* Thunb., *Oxalis* 16. 1781. Type: Africa. Cultivated at Uppsala, *Thunberg 11118* (holotype: UPS-THUNB?).

Oxalis corniculata var. *viscidula* Wieg., Rhodora 27:121. 1925. Type: U.S.A. Massachusetts. Hampshire Co.: Northampton, 1902, *Mrs. E.H. Terry s.n.* (holotype: GH!).

Oxalis corniculata var. *villosa* (M. Bieb.) Hohen., Bull. Soc. Imp. Naturalistes Moscou 11:395. 1838. *Oxalis villosa* M. Bieb., Fl. Taur.-Caucas. 1:355. 1808. Type: ALBANIA. Protologue: "Habitat in Albania ibericae lapidosis inumbratis. D. Steuen."

Plants perennial, caulescent, arising from thin to lignescent taproots. **Stems** 4–10(–30) cm, several and radiating laterally from the taproot, creeping, rooting at the nodes and stolonlike, prostrate to distally ascending-erect, initially herbaceous but lignescent, sparsely and loosely strigose to strigose-villous. **Stipules** present, membranous, margins with free flanges, distal auricles free. **Leaves** basal and cauline; leaflets 3, obcordate, lobed 1/5–1/3 length, (4–)6–12 mm, green on both surfaces or bronze-purple to maroon, margins often prominently villous-ciliate, petioles 1–5 cm. **Flowers** 1 or 2–3(–6) in irregular or umbelliform cymes, mostly homostylous; peduncles (1–)2–4(–8) cm; pedicels in fruit horizontal to deflexed; petals 4–8 mm, yellow. **Capsules** angular-columnar, gradually or abruptly tapering to apex, 8–17(–20) mm, sparsely puberulent to glabrate or glabrous. **Seeds** uniformly brown, transverse ridges brown. $2n = 24, 36, 42, 44, 48$.

Flowering Mar–Aug, sporadically all year in Florida. Gardens, greenhouses, lawns, fields, roadsides, hammocks, beach margins, open pine woods, grasslands; 10–500(–2500) m; Nfld.!, Ont.!, P.E.I.!; Ala.!, Ark.!, Calif.!, Colo.!, Conn.!, D.C.!, Fla.!, Ill.!, Ind. (fide Kay Yatskievych), La.!, Me.!, Mass.!, Mo.!, N.J.!, N.C.!, Oreg.!, Pa.!, S.C.!, Tex.!, Vt.!, Va.!, W.Va.!; introduced; native to Mexico, West Indies, Central America, South America; introduced Europe, Asia (India, China, Japan), Africa, Pacific Islands, Australia. The PLANTS Database shows records for Ariz., Ga., Nebr., Ohio, Okla, S.Dak., and Wash.

Many infraspecific taxa of *Oxalis corniculata* in the broad sense have been described over its cosmopolitan range, but their taxonomic status is uncertain and only the single entity is treated here. The reported variation in ploidy level is a concomitant of the complex morphological variation.

Oxalis corniculata in the USA is recognized by its relatively small flowers, sparsely hairy stems creeping and rooting at nodes, all procumbent and radiating from the taproot, and its well-developed stipules with broad, free marginal flanges and auricled apices. Peduncles and 1 or 2–3 leaves are produced at the nodes, short erect stems rarely. Plants flower as annuals but often become short-lived perennials through the colonial habit. Stems of *O. dillenii* sensu stricto may be decumbent or prostrate and rooting at the nodes, but they almost always are ligneous to lignescent, not evidently radiating from the taproot, and erect stems characteristically arise from the nodes. According to Eiten (1963), *O. dillenii* is able to form "vigorous, floriferous, but sterile hybrids with *O. corniculata*."

Plants of *Oxalis corniculata* with bronze-purple to maroon leaves and pubescent capsules have been recognized as *O. corniculata* var. *atropurpurea* (e.g., in Florida, Ward 2004; in California, Abrams 1951). Such plants apparently occur sympatrically with the typical expression and it is not clear whether they are populational variants or whether they are at least partially reproductively isolated. In Malaysia, var. *atropurpurea* differs from typical *O. corniculata* in karyotype as well as in floral and vegetative morphology and is isolated by post-pollination reproductive barriers (Nair & Kuriachan 2004)—at least in that region its biological behavior indicates that var. *atropurpurea* should be treated at specific rank. Distinctive Australasian variants sometimes identified as *O. corniculata* have recently been treated as distinct species (e.g., de Lange et al. 2005). A form of *O. corniculata* is common in central Mexico (collections seen from Hidalgo, Jalisco, Edo. Mexico, Michoacan, Morelos, and Querétaro)—these plants produce large, prominent stipules and nearly glabrous stems, but the habit varies from procumbent to ascending and the stems rarely root at the nodes.

Most of the closest relatives of *Oxalis corniculata* (in its American expression) occur in the Americas and West Indies and the species probably is native there, though probably south of the United States. In the USA, *O. corniculata* occurs mostly in urban and highly disturbed habitats, but along the Gulf coast it occasionally grows in less obviously disturbed sites. North of the Gulf Coast, its occurrence is mostly restricted to greenhouses and horticultural sites (lawns and gardens), suggesting that it is repeatedly introduced rather than persisting (and expanding) through seed production.

2. Oxalis dillenii Jacq., Oxalis Mon. 28. 1794. *Oxalis corniculata* L. var. *dillenii* (Jacq.) Trel. in A. Gray, Syn. Fl. N. Amer. 1(1):365. 1897. *Xanthoxalis dillenii* (Jacq.) Holub, Bot. Közlem. 59:38. 1972. Type: Jacquin noted in the protologue "Plantam non vidi. Omnia ex Dillenio desumpsi" (Plant not seen. It is entirely selected from Dillenius), thus the name is based on the description and illustration by Dillenius in Hortus Elthamensis 2: f. 298, t. 221. 1732. The plant illustrated probably was raised from seed from a collection made by Mark Catesby, as Sherard and Dillenius had received nearly a full set of Catesby's specimens from eastern North America (Reveal 1983). It apparently is the specimen in Dillenius's herbarium under his phrase-name "Oxys lutea americana, humilior et annua," *Dillenius s.n.* (holotype: OXF).

Eiten (1955, p. 104) observed that "Although the original Dillenius plate is distinctive, there is also a plant in the Hortus Elthamensis herbarium which is almost surely the plant Dillenius used (Druce & Vines 1907, p. 176), and therefore, if unique, is the holotype." Watson (1989, p. 361) also noted that "the Dillenian reference must be considered for holotype material, since his was the only cited work [i.e., cited by Jacquin]." Lourteig (1979) cited "Tipo: America, Hort. Elth. OXF."

Oxalis dillenii var. *radicans* Shinners, Field & Lab. 24:39. 1956. Type: U.S.A. Texas. Freestone Co.: 4.8 mi SSE of Streetman, 28 Apr 1956, *L.H. Shinners 23872* (holotype: SMU!; isotype: GH-2 sheets!).

Oxalis lyonii Pursh, Fl. Amer. Sept. 1:322. 1814 [1813]. *Oxalis corniculata* L. var. *lyonii* (Pursh) Zucc., Denkschr. Königl. Akad. Wiss. München ser. 2, 1: 230. 1831. Type: U.S.A. Georgia. [Camden Co.]: Cumberland Island, Jun [ca. 1800-1813], *John Lyon s.n.* (herb. Lyon, lost or destroyed, fide Ewan & Ewan 1963). Neotype, designated here: Florida. [Duval Co.:] Near Jacksonville, "188-", *A.H. Curtiss s.n.* (NCU 69362, digital image!). Curtiss made collections from "near Jacksonville" at least in 1893, 1894, 1896, 1897, and 1898; the NCU sheet has only "188" printed, lacking the last digit of the date. Jacksonville, in Duval Co., Fla., is very close to Camden Co., Ga., separated only by about 25 mi, mostly in Nassau Co. Fla.

The neotype designated here replaces the one designated by Lourteig (1979), a collection selected from southern Mississippi, in conflict with Pursh's protologue—which unambiguously places the type locality in southeastern Georgia (see comments by Ward 2004)—and intended by Lourteig to represent a species (*O. texana*, as identified here) restricted to eastern Texas, southern Arkansas, and west and central Louisiana. Lourteig's selection is from Mississippi (Harrison Co.: Henderson Point, 18 Mar 1954, *Demaree 34767*–GH!; duplicate: USF) and is a plant of *O. dillenii* (as noted by Eiten 1963 and as annotated by him in 1965; confirmed as *O. dillenii* in the present study, 2009), out of geographical range for *O. texana*.

Oxalis recurva Ell. var. *floridana* Wieg., Rhodora 27:138. 1925. Type: U.S.A. Florida: East Florida, no date, *D.C. Eaton s.n.* (holotype: GH!).

Oxalis stricta var. *piletocarpa* Wieg., Rhodora 27:123. 1925. Type: U.S.A. New Hampshire. [Cheshire Co.]: Alstead, old gravel pit, 1901, *E.F. Williams* (holotype: GH!).

Plants perennial, caulescent, arising from a ligneous or lignescent rhizome, sometimes appearing taproot-like. **Stems** 10–25 cm, proximally ligneous to lignescent, 1.5–2 mm thick, usually 2–8 from the base, erect initially, often becoming decument to prostrate and rhizome-like, sometimes rooting at nodes, strigillose to strigose with antrorsely appressed, nonseptate, sharp-pointed hairs. **Stipules** usually greatly reduced at least above midstem, margins narrowly flanged or without any free portion, without free apical auricles. **Leaves** basal and cauline; leaflets 3, obcordate, lobed 1/5–1/3 length, (4–)6–15(–21) mm, green on both surfaces, glabrous adaxially, sparsely strigillose abaxially, petioles 1–4 cm. **Flowers** 1 or 2–3(–4, very rarely to 8) in umbelliform (rarely irregular) cymes, mostly homostylous; peduncles 1–6(–10) cm; pedicels in fruit deflexed (to horizontal), usually without bracteoles; petals 5–11 mm, yellow. **Capsules** angular-columnar, abruptly tapered at apex, 12–20(–25) mm, densely strigose-pilose with mixture of appressed and spreading hairs, with a puberulent understory. **Seeds** brownish, tranverse ridges with strong grayish or white lines. $2n = 18, 20, 22, 20–24$.

Flowering Feb–May(–Oct). Pastures, roadsides, lawns, river bottoms, sandy, rocky, or gravelly soils;

5–300 m; N.B.!, N.S.!, Ont.!, P.E.I.!, Que.!, Sask.!; Ala.!, Ark.!, Ariz.!, Colo.!, Conn.!, Del.!, D.C.!, Fla.!, Ga.!, Ill.!, Ind.!, Iowa!, Kans.!, Ky.!, La.!, Maine!, Md.!, Mass.!, Mich.!, Minn.!, Miss.!, Mo.!, Nebr.!, N.H.!, N.J.!, N.Mex.!, N.Y.!, N.C.!, N.Dak.!, Ohio!, Okla.!, Pa.!, R.I.!, S.C.!, S.Dak.!, Tenn.!, Tex.!, Va.!, Vt.!, Wash.!, W.Va.!, Wis.!, Wyo.!; introduced in Bermuda, Europe. The PLANTS Database shows records from Alta, Man., Idaho, and Oreg.

Decumbent branches of *Oxalis dillenii* often appear as stoloniform, producing erect branches and leaves at the nodes, rarely producing a few, small adventitious roots. Such plants sometimes are misidentified as *O. corniculata*, but they differ in their overall habit, ligneous stems and rhizomes, reduced stipules, strigillose cauline vestiture, denser fruit vestiture, and seed color. In *O. dillenii*, the stems are consistently strigose, while the long petioles commonly are pilose-villous, and in a quick scan of a specimen not carefully pressed, stem vestiture might be misinterpreted.

Oxalis dillenii may continue to flower, or begin to reflower, in moist places especially in the fall. Plants are often abundant in lawns and other mowed areas, and later-flowering plants commonly produce very small flowers. The species shows much plasticity in habit, some of which may be genetically partitioned, as dysploid chromosome races apparently exist.

Oxalis dillenii and *O. stricta* are the two most abundant species of the eastern United States and both commonly occur in disturbed sites. In view of recent nomenclatural confusion (see comments below, under *O. stricta*), a key that separates these two is presented here.

1. Stems usually 2–8 from the base, 10–25 cm, erect initially, often becoming decument to prostrate and rhizome-like, sometimes rooting at nodes; stem vestiture strigose to strigillose from base to peduncles and pedicels with antrorsely appressed, nonseptate, sharp-pointed hairs; plants arising from a taproot, producing ligneous or lignescent rhizomes or stolons; flowers 1 or 2–3(–5, rarely to 8) in umbelliform cymes ____________ **Oxalis dillenii**
1. Stems usually arising singly from the base (rarely 2–3 together), 20–60(–90) cm, erect or later leaning or falling over and decumbent; stem vestiture very sparsely to sparsely or moderately pilose or villous with nonseptate hairs or a mixture of nonseptate and septate hairs **or** densely villous with septate hairs; plants arising from a thin, short herbaceous to lignescent rhizome; flowers usually (3–)5–7(–15) in regular (rarely irregular) cymes ____________ **Oxalis stricta**

3. Oxalis priceae Small, Bull. Torrey Bot. Club 25:612. 1898. *Xanthoxalis priceae* (Small) Small, Fl. S.E. U.S. 668. 1903. Type: U.S.A. Kentucky. Warren Co.: Bowling Green, rocky hillsides, open woods, fields, and roadsides, 6 Nov 1898, *S.F. Price s.n.* (lectotype, Eiten 1963: NY, NY-digital image!).

Oxalis caespitosa Raf., New Fl. N. Amer. 2:27. 1838 (non *O. caespitosa* A. St. Hil. 1825). Type: U.S.A. Kentucky: glades of West Kentucky and Tennessee, May–Jun 1823, *C.S. Rafinesque s.n.* (lectotype, Lourteig 1979: P).

Oxalis macrantha (Trel.) Small, Fl. S.E. U.S. 667. 1903. *Oxalis corniculata* L. var. *macrantha* Trel., Mem. Boston Soc. Nat. Hist. 4:88, pl. 11, fig. 5. 1888. *Oxalis recurva* Ell. var. *macrantha* (Trel.) Wieg., Rhodora 27:138. 1925. Type: U.S.A. Alabama. Alabama, no date, *P. Hatch s.n.* (lectotype, Lourteig 1979: GH!).

Oxalis hirsuticaulis Small, Bull. Torrey Bot. Club 25:611. 1898. Type: U.S.A. Tennessee. Davidson Co.: Nashville, [no date], *A. Gattinger s.n.* (holotype: NY, NY-digital image!). *Oxalis hirsuticaulis* was published in the same article as *O. priceae*—adoption of the latter here follows Eiten's original choice in 1955.

Oxalis recurva Ell. var. *macrantha* (Trel.) Wieg. forma *sericea* Wieg., Rhodora 27:138. 1925. Type: U.S.A. Alabama: no other data, *Dr. Cabell s.n.* (holotype: GH!).

Xanthoxalis colorea Small, Fl. S.E. U.S. 668, 1333. 1903. *Oxalis priceae* subsp. *colorea* (Small) Eiten, Amer. Midl. Naturalist 69:302. 1963. Type: U.S.A. Georgia. DeKalb Co.: On and about Stone Mt., 100–1500 ft, 1-16 May 1895, *J.K. Small s.n.* (holotype: NY, NY-digital image!; isotypes: F, NY, NY-digital image!).

Plants perennial, caulescent, arising from a ligneous or lignescent taproot, usually with lignescent, stoloniform (or offset-like) rhizomes rooting at nodes and producing erect stems from the nodes. **Stems** proximally lignescent, usually 2–8 from the base, 5–20(–40) cm, erect or usually becoming decumbent, villous-hirsute with nonseptate hairs spreading or deflexed or spreading in dissimilar orientations. **Stipules** with margins narrowly flanged or without any free portion, without free apical auricles. **Leaves** basal and cauline; leaflets 3, obcordate, lobed 1/5–1/3 length, 3.5–12 mm, green on both surfaces, strigose-hirsute on both surfaces, less commonly glabrate, petioles 2–7 cm. **Flowers** 1 or (2–)3–8 in umbelliform cymes, less commonly irregular cymes, produced well above the level of the leaves, distylous; peduncles (3–)5–10(–15) cm; pedicels in fruit deflexed to horizontal, often bracteolate; petals (13–)14–20 mm, yellow, with prominent red stripes at the base (corolla throat). **Capsules** angular-cylindric, abruptly tapered at apex, 10–15 mm, sparsely to densely villous with long, deflexed, nonseptate hairs, less commonly puberulent with short, straight, deflexed hairs. **Seeds** usually with white transverse ridges. 2*n* = unknown.

Flowering Mar–May. Dry limestone areas, glades, cedar barrens, chalk prairies, limestone bluffs and outcrops, sandstone cliffs, rocky slopes, talus, sandy hedgerows, oak-pine, longleaf pine; 5–300 m; Ala.!, Fla.!, Ga.!, Ky.!, Miss.!, N.C.!, S.C.?, Tenn.!; Mexico (Nuevo León!).

Oxalis priceae is a distinctive species of the southeastern USA, recognized by its villous to villous-hirsute stems, flowers in umbelliform cymes, and large yellow to yellow-orange corollas with red lines in the throat. The lines in the throat remain visible after drying and usually can be seen on herbarium specimens even from the outside of the flower. A similar pattern also occurs in *O. texana*, *O. illinoensis*, and *O. grandis*.

Plants of *Oxalis priceae* in Mississippi and eastern Louisiana grow in pineland and have slightly smaller corollas than those eastward. Vouchers for Lousiana records are cited here. Jefferson Par.: at Gretna, opposite New Orleans, 6 May 1899, *Ball 352* (GH); Rapides Par.: Red River valley, near Zimmerman RR Sta., frequent in dryer spots beneath tall pines on crest of hills, 24 Apr 1948, *Ewan 17608* (MO); St. Tammany Par.: 5 mi S of Pearl River, US 90, hwy embankment, 30 Apr 1953, *Ewan 18546* (GH).

Two collections from a single area in North Carolina are typical *Oxalis priceae*, at the northeastern extremity of its main range. Stanly Co.: rocky slopes below bluffs of Yadkin River, near Charlotte, 20 Apr 1932, *Palmer 39985* (GH); steep moist banks above the Yadkin River, just above the second or lower power dam east of Badin, 10 May 1963, *Wilbur 6826* (GH). Similarly, a collection of *Oxalis priceae* from eastern Tennessee appears to be disjunct. Cocke Co.: near Del Rio, siliceous bluffs along Newport Rd., 18 Apr 1963, *Sharp et al. 17255* (TENN digital image!). Further study may fill in the known distribution, especially in Georgia and South Carolina, so that the Cocke Co. and Stanly Co. localities no longer appear disjunct.

Two collections from montane Nuevo León, Mexico, are unmistakably *Oxalis priceae*, disjunct from the closest localities in the southeastern USA by about 900 kilometers. Nuevo León. Mpio. Santiago, along the Cola de Caballo-Laguna Sanchez road into high sierra SE of Monterrey, between Puerto Genovevo and La Cienega, ca. 1.5-2.5 air km NW of Puerto Genovevo, temperate pine-oak-hickory dominated by Pinus, Carya ovata, 1500 m, 15 Mar 1994, *Mayfield 1887* (TEX); Mpio. Bustamante, along switchbacks of road below the Grutas de Bustamante, ravines and bluffs along road from opening of cave to ca. 4 road km below cave, *Quercus-Cercis-Brahea-Ungnadia-Fraxinus greggii*, dark, rich, rocky soil in talus slopes, 1000 m, fairly common in moist ravine to E of cave opening, 18 Mar 1994, *Mayfield 1908* (TEX).

4. Oxalis texana (Small) Fedde, Just's Bot. Jahresber. 32:410. 1905. *Xanthoxalis texana* Small, Fl. S.E. U.S. 667, 1332. 1903. *Oxalis recurva* Ell. var. *texana* (Small) Wieg., Rhodora 27: 138. 1925. *Oxalis priceae* Small subsp. *texana* (Small) Eiten, Amer. Midl. Naturalist 69:301. 1963. TYPE: U.S.A. TEXAS. Brazoria Co.: Alvin, 20 Apr 1894, *E.N. Plank s.n.* (HOLOTYPE: NY, NY-digital image!).

Plants perennial, caulescent, arising from a woody taproot, caespitose with stems arising from a caudex or with rhizome-like offsets or stolons rooting at the nodes. **Stems** 5–15 cm, proximally ligneous to lignescent, erect to ascending, strigose to strigillose with antrorsely appressed to ascending nonseptate hairs. **Stipules** usually with margins very narrowly flanged, usually with rounded and slightly free apical auricles. **Leaves** basal and cauline, leaflets 3, cordate, lobed 1/5–1/3 the length, (4–)6–12(–18) mm long, green to purple on both surfaces, glabrous to sparsely strigose adaxially, sparsely strigose abaxially; petioles 2–6 cm long. **Flowers** (2–)3–5(–8) in umbelliform cymes, very rarely irregular cymes, distylous, peduncles 4–10 cm; pedicels horizontal to deflexed in fruit, without bracteoles; petals (10–)12–16(–17) mm long, yellow, with prominent red lines at the base (corolla throat). **Capsules** angular-columnar, abruptly tapered at apex, 8–15 mm long, moderately to densely puberulent to puberulent-villous. **Seeds** brownish, transverse ridges distinctly whitish. 2*n* = unknown.

Flowering Mar–May(–Jun). Commonly in undisturbed habitats and usually in deep, loose sand, but also fields, roadsides, and edges and openings in woods, pine, pine-oak, and mixed hardwoods; 10–200 m; Ark.!, La.!, Tex.!

Oxalis texana is very similar to *O. dillenii*—differing from *O. dillenii* primarily in its more numerous flowers per inflorescence and larger, distylous flowers with red-lined corolla throats. The distinctive red striping in the corolla throat remains visible after drying and usually can be seen on herbarium specimens even from the outside of the flower. Plants of *O. texana* also are distinct in their relatively larger taproots and habit either caespitose or with short stolon-like offsets. Plants of *O. dillenii* with larger flowers on elevated peduncles might be mistaken for *O. texana*, yet the two taxa exist sympatrically in the range of *O. texana* and it seems clear that they are separate species. *Oxalis priceae* and *O. texana* are separate in geography and morphology.

Lourteig (1979) used the name *Oxalis lyonii* Pursh for the species identified here as *O. texana*, and her illustrations of *O. lyonii* were drawn from a Texas collection identified here as *O. texana* (Lourteig 1979, Fig. 7, a-e). Turner et al. (2003) followed Lourteig's nomenclature and mapped the same species as *O. lyonii*. Lourteig neotypified *O. lyonii* to place it within her concept of *O. texana* (as identified here) and included *O.* [*Xanthoxalis*] *texana* in synonymy—her neotype, however, is from southern Mississippi, outside of the range of *O. texana*, and is instead a collection of *O. dillenii* (as noted by Eiten 1963 and annotated by him in 1965; confirmed here as *O. dillenii*). Further comments regarding *O. lyonii* are in the synonymy of *O. dillenii* in the present paper.

5. Oxalis florida Salisb., Prodr. Stirp. Chap. Allerton, 322. 1796. TYPE: from seeds from South Carolina, probably collected by John Fraser, cultivated in Hortus Chapel Allerton, 1789, *Salisbury s.n.* (HOLOTYPE: BM; ISOTYPE: G-DC). Fide Lourteig 1979.

Oxalis brittoniae Small, N. Amer. Fl. 25:52. 1907. TYPE: U.S.A. NEW YORK. Richmond Co.: Giffords, Staten Island, 19 May 1889, *N.L. Britton s.n.* (HOLOTYPE: NY, NY-digital image!).

Oxalis filipes Small in Britton & Brown, Ill. Fl. N. U.S. 2:346. 1897. *Oxalis florida* Salisb. var. *filipes* (Small) Ahles, J. Elisha Mitchell Sci. Soc. 88:172. 1964. *Xanthoxalis filipes* (Small) Small, Fl. S.E. U.S. 667. 1903. *Oxalis dillenii* Jacq. subsp. *filipes* (Small) Eiten, Amer. Midl. Naturalist 69:301. 1963. TYPE: U.S.A. NORTH CAROLINA. Stanley Co.: Falls of the Yadkin River, 100–200 ft, 23 Aug 1894, *J.K. Small 61* (LECTOTYPE, Eiten 1963: NY, NY-digital image!; DUPLICATES OF THE LECTOTYPE: F, MO!, MSC, NY, NY-digital image!).

Oxalis prostrata Haworth, Misc. Natur. 183. 1803. *Oxalis florida* Salisb. subsp. *prostrata* (Haworth) Lourteig, Phytologia 42:156. 1979. TYPE: USA, cultivated in England, *Haworth s.n.* (destroyed). TYPE: U.S.A. VIRGINIA. Henrico Co.: dry cinders of RR embankment W of Elk Station, 21 Oct 1938, *M.L. Fernald and B. Long 9355* (NEOTYPE, Lourteig 1979:US, US-digital image!; ISONEOTYPE: GH!). Lourteig cited the collection date as 21 Sep 1928.

Oxalis recurva Ell., Sketch Bot. S.C. 1:526. 1821. *Oxalis florida* Salisb. var. *recurva* (Ell.) Ahles, J. Elisha Mitchell Sci. Soc. 80:173. 1964. *Oxalis dillenii* Jacq. subsp. *recurva* (Ell.) C.F. Reed, Phytologia 63:411. 1987. TYPE: U.S.A. SOUTH CAROLINA: In cultis at pascuis circa Charleston, Apr, *Elliot s.n.* (CHARL, photo-GH!). Eiten (1963) noted that the type specimen, lacking flowers, of *O. recurva* has habit and stem vestiture that would place it with equal probability as either *O. priceae* [subsp. *priceae*] or *O. florida*. Geography places it with the latter, though Eiten chose to keep it as a "nomen dubium." Elliott's protologue noted "Very common near Charleston, intermingled with the *O. stricta*, with which it has been confounded."

Oxalis rupestris Raf., New Fl. N. Amer. 2:26. 1838 (non *O. rupestris* A. St. Hil. 1825). TYPE: U.S.A. KENTUCKY: Kentucky, 1823?, *Rafinesque s.n.* (LECTOTYPE, Lourteig 1979:P).

Plants perennial, caulescent, arising from slender lignescent stolons, youngest plants from short, slender taproots. **Stems** usually single from the base, (5–)8–30(–35) cm, erect or rarely leaning and decumbent, subglabrous to sparsely to moderately pilose-villous with very fine hairs spreading in irregular orientation, sometimes strigose distally or just beneath the flowers and pilose-villous on proximal portions. **Stipules** obsolescent, without free margins or apical auricles. **Leaves** basal and cauline, leaflets 3, obcordate, lobed 1/5–1/3 length, 4–11 mm long, green on both surfaces, sparsely strigose abaxially; petioles 2–5 cm. **Flowers** 1 or 2(–3, rarely 4–6) in umbelliform cymes at level of the leaves or slightly above, tristylous; peduncles (2–)3–8 cm; pedicels reflexing to ascending, often bracteolate; petals 5–9(–11) mm, yellow. **Capsules** angular-cylindric, 8–12(–15) mm, glabrous to sparsely puberulent. **Seeds** brownish, including transverse ridges. 2*n* = 16.

Flowering Mar–May(–Aug). Low woods, swamp forests, rich woods, pine woods, sandy sites, burned-over woods, ditches, roadside banks, floodplains, low fields, lake edges, creek banks, pastures, disturbed sites, bluffs, rocky slopes; 10–350 m; Ala.!, Ark.!, Conn.!, D.C.!, Fla.!, Ga.!, Ind. (fide Kay Yatskievych), Ky.!, La.!, Maine!, Md.!, Mass.!, Miss.!, Mo.!, N.J.!, N.Y.!, N.C.!, Pa.!, S.C.!, Tenn.!, Vt.!, Va.!, W.Va.!

Oxalis florida is recognized by its mostly erect stems, sparse and spreading cauline vestiture without multicellular hairs, obsolescent stipules, relatively small, and yellow flowers without red lines in the throat; the distal stems and peduncles are thin compared to other species. It is a species primarily of the Atlantic states and Gulf coast, much more sparsely represented in more inland regions. It is known from a cluster of counties in southeastern Missouri (Butler, Carter, Ripley, and Wayne cos.; MO!), and from southern Arkansas (Ashley, Bradley, and Ouachita cos.; BRIT!, NLU!) northward to apparently isolated localities in Arkansas (e.g., Yell Co.; MO!). The voucher for the West Virginia record perhaps was a waif—Tucker Co.: Otter Creek Lumber Co., near Hendriks, dry grounds along railroad track, 10 Sep 1904, *Greenman 400* (GH). A collection annotated by Eiten as *O. dillenii* var. *filipes* is interpreted here as *O. dillenii* with slightly reduced vestiture, perhaps resulting from damaged stems: Polk Co: 12 Apr 1941, *Tharp s.n.* (GH).

Lourteig (1979) also treated *Oxalis florida* at specific rank, and for Florida, Ward (2004, p. 35) noted that "the differences between *O. dillenii* subsp. *dillenii* and subsp. *filipes* (= *O. florida*) "are appreciable and intermediates seem few." In contrast, Eiten (1963, p. 268) observed that *Oxalis dillenii* subsp. *filipes* "is distinctive in its most characteristic form but intergrades with [subsp. *dillenii*], both in forming intermediate homogeneous populations and also, in disturbed ground, variable hybrid swarms. The most distinctive portion of this variable subspecies is concentrated in the northern Appalachians. The morphological evidence is conflicting as to whether it originated from [subsp. *dillenii*] or directly from [*O.*] *corniculata*."

Wiegand (1925, p. 124), preceding Eiten, also observed a measure of intermediacy in *Oxalis florida*, noting that "*O. florida* and *O. filipes* have much the appearance of hybrids between [*O. stricta* and either *O. dillenii* or *O. corniculata*], as no new characters are found in either species. The frequency of their occurrence in the east and absence in the west, where the possible parents both occur is against this hypothesis."

Ward (2004, p. 35) noted that Eiten was incorrect in claiming that the name *Oxalis florida* Salisb. is illegitimate. "The name [phrase-name] cited in synonymy by Salisbury (1796) was pre-Linnaean which, since not available for his use, does not disturb the legitimacy of *O. florida*."

In Eiten's view (1963), the difference between *Oxalis dillenii* subsp. *filipes* and *O. priceae* subsp. *colorea* was primarily in flower size. Subsp. *filipes* keyed under "Flowers 13 mm long or less," while subsp. *colorea* keyed under "Flowers 10 mm long or more." The seemingly arbitrary difference in size apparently is reflected in his comment that he identified a duplicate (F) of the type of *Xanthoxalis colorea* as *O. dillenii* subsp. *filipes*.

In the current study, I have sorted collections previously identified as *Oxalis priceae* subsp. *colorea* mostly between *O. florida* and *O. priceae*, and the reality of subsp. *colorea* remains somewhat in doubt, even though it is placed here as a synonym of *O. priceae*. Mulcahy (1964, p. 1048) found that both *O. priceae* sensu stricto and *O. priceae* subsp. *colorea* exhibit a high degree of self-fertility, the former strictly distylous, the latter tristylous. "A further difference between the 2 subspecies is that subspecies *priceae* forms very dense and extensive clones, some of which extend for several meters, while subspecies *colorea* forms rather diminutive clones, very few of which contain more than 3–4 flowering stalks." Ward did not find significant variation within *O. priceae*, listing *Xanthoxalis colorea* as a synonym.

6. Oxalis stricta L., Sp. Pl. 1:435. 1753. TYPE: Morison, Pl. Hist. Univ. 2:184, s. 2, t. 17, fig. 3. 1680 (LECTOTYPE. Eiten 1955). The protologue noted "Habitat in Virginia."

Lourteig (1979) identified this species as *Oxalis fontana*, typified by a plant from northern China, and applied the name *O. stricta* to the species identified by Eiten (1955, 1963) and here as *O. dillenii*. The basis for the difference lies in selection of lectotypes for *O. stricta*. Lourteig (1979), and earlier Robinson (1906), opined that Linnaeus worked with Gronovius and was most likely to have been familiar with a John Clayton specimen in the Gronovius collection (*Clayton 474*, BM, photo-GH!, BM-Clayton-digital image!)—this plant identified here as *O. dillenii*. Eiten (1955), followed by Jarvis (2007), noted that selection of a Morison illustration as lectotype of *O. stricta* best characterizes the species long-naturalized and weedy in Europe and probably known first-hand by Linnaeus. The situation has been excellently summarized by Ward (2004).

Oxalis bushii Small, Bull. Torrey Bot. Club 25:611. 1898. *Oxalis europaea* var. *bushii* (Small) Wieg., Rhodora 27:135. 1925. *Oxalis stricta* var. *bushii* (Small) Farwell, Mich. Acad. Sci. Rep. 20:183. 1918. *Oxalis fontana* var. *bushii* (Small) H. Hara, J. Jap. Bot. 24:106. 1949. TYPE: U.S.A. MISSOURI. Jackson Co.: NW Jackson Co., dry ground, 28 May 1893, *B.F. Bush 30* (HOLOTYPE: NY, NY-digital image!; ISOTYPE: GH!).

Oxalis coloradensis Rydb., Bull. Torrey Bot. Club 29:243. 1902. TYPE: U.S.A. COLORADO. Larimer Co.: Sangre de Christo Creek, 2400–2700 m, 2 Jul 1900, *P.A. Rydberg 5920* with F.K. Vreeland (HOLOTYPE: NY, NY-digital image!; ISOTYPE: NY, NY-digital image!).

Oxalis cymosa Small, Bull. Torrey Bot. Club 23:267. 1896. *Oxalis europaea* forma *cymosa* (Small) Wieg., Rhodora 27:135. 1925. TYPE: U.S.A. NEW YORK. [Bronx Co.]: Riverdale, 26 Aug 1894, *E.P. Bicknell s.n.* (possible HOLOTYPE: NY, NY-digital image!).

Oxalis europaea Jordan in F. Schultz, Arch. Fl. France Allemagne 309. 1854. TYPE: Apparently no type exists for this name. Jordan reckoned that the European plants were not the same species as the American ones identified as *Oxalis stricta* L. and because Linnaeus had indicated that *O. stricta* is uniquely American, he provided a new name for the Europaean ones. He noted that the species "est si commune in beaucoup des localités, et on la trouve si loin des lieux habités, qu'il est fort difficile d'admettre qu'elle nous soit venue d'Amérique et ne soit pas réellement une espèce indigène." There was no more specific indication of any potential type or types than this. Neither Wiegand (1925), Eiten (1955), nor Lourteig (1979) provided any information on the typification of *O. europaea.* Wiegand (1927, p. 136) noted that "*O. europaea* is with little doubt a native of America, but was introduced into Europe about 1658. It seems to have been cultivated by Morison in 1660 and was figured by him in his Historia. An outline of the early history of this species is given by Ascherson and Graebner [1913, Vol. 7:149]."

Oxalis europaea Jordan forma *pilosella* Wieg., Rhodora 27:135. 1925. TYPE: U.S.A. MISSOURI. Jackson Co.: Courtney [Greenwood], 20 May 1912, *B.F. Bush 6701* (HOLOTYPE: GH!; ISOTYPES: NY, US, US-digital image!).

Oxalis europaea Jordan forma *subglabrata* Wieg., Rhodora 27:136. 1925. TYPE: USA. Iowa. [Story Co.]: Ames, *Pammel and Ball 4* (HOLOTYPE: GH!; ISOTYPE: MO!, MO-digital image!, US, US-digital image!).

Oxalis europaea Jordan forma *vestita* Wieg., Rhodora 27:136. 1925. TYPE: U.S.A. MASSACHUSETTS. [Middlesex Co.]: Cambridge, 1904, *Miss I.W. Anderson s.n.* (HOLOTYPE: GH!).

Oxalis europaea Jordan forma *villicaulis* Wieg., Rhodora 27:135. 1925. *Oxalis stricta* var. *villicaulis* (Wieg.) Farwell, Amer. Midl. Naturalist 11:62. 1928. TYPE: USA. Michigan. [St. Clair Co.]: Port Huron, 1914, *C.K. Dodge 41* (HOLOTYPE: GH!).

Oxalis fontana Bunge, Enum. Pl. China Bor. 13. 1833. TYPE: CHINA: "Borealis, Pan-Sham, hab. ad fontam," 1831, *A.A. Bunge s.n.* (HOLOTYPE: P; ISOTYPES: E, P). Fide Lourteig (1979).

Oxalis interior (Small) Fedde, Just's Bot. Jahresber. 32:410. 1905. *Xanthoxalis interior* Small, Fl. S.E. U.S., 668. 1903. TYPE: U.S.A. ARKANSAS. Benton Co.: no other locality data, 1899, *E.N. Plank s.n.* (LECTOTYPE, Eiten 1955:NY, NY-digital image!; ISOLECTOTYPE: NY, NY-digital image!).

Plants annual to short-lived perennial, caulescent, arising from a thin, short rhizome. **Stems** usually arising singly from the base (rarely 2–3 together), erect or later leaning or falling over and decumbent, 20–60(–90) cm, villous with nonseptate hairs, spreading septate hairs present on stems and petioles, commonly concentrated at nodes, sometimes only on petioles. **Stipules** obsolescent, without free margins or apical auricles. **Leaves** basal and cauline; leaflets 3, obcordate, lobed 1/5–1/3 length, (8–)10–20(–30) mm, light green to yellowish-green on both surfaces, petioles 2–8 cm. **Flowers** rarely 1 usually (3–)5–7(–15) in regular cymes, less commonly in irregular cymes, usually within level of the leaves or slightly above, homostylous or slightly to strongly heterostylous; peduncles 3–9(–11) cm; pedicels in fruit erect to ascending, often bracteolate; petals (6–)8–11 mm, yellow. **Capsules** columnar, nearly terete, abruptly tapering toward apex, 8–15 mm, villous with septate hairs to glabrate. **Seeds** brown, transverse ridges rarely whitish. $2n = 18, 24$.

Flowering (Apr–)Jul–Oct. Prairie ravines, river and stream banks, sand bars, low woods, floodplains, roadsides, fields, lawns, gardens; 20–1200 m; B.C., Man., N.B.!, Nfld., N.S.!, Ont.!, P.E.I.!, Que.!; Ala.!, Ark.!, Colo.!, Conn.!, Del.!, D.C.!, Ga.!, Idaho, Ill.!, Ind.!, Iowa!, Kans.!, Ky.!, La.!, Maine!, Mass.!, Md.!, Mich.!, Minn.!, Miss.!, Mo.!, Nebr.!, N.H.!, N.J.!, N.Y.!, N.C.!, N.Dak.!, Ohio!, Okla.!, Pa.!, R.I.!, S.C.!, S.Dak.!, Tenn.!, Va.!, Vt.!, W.Va.!, Wis.!; introduced in Europe, Asia, Africa, Pacific Islands (New Zealand), Australia. The PLANTS Database shows records from Nfld., Sask., Ariz., Mont., N.Mex., Wash., and Wyo.

Oxalis stricta is recognized by its tall, erect stems from a short, simple rhizome, presence of septate hairs, cymose inflorescence, and relatively small flowers. Septate hairs on the stems and petioles are easily recognized (lens), especially because of their brownish crosswalls, but they vary greatly in density, as do the nonseptate hairs. In "villicaulis" and "pilosella" forms, as well as "var." bushii, the septate hairs are dense and evenly distributed on the stems, but more often they are localized around the nodes and intermixed with nonseptate hairs. Often they are few in number, and, in rare cases, plants with greatly reduced vestiture overall apparently lack septate hairs.

The rhizomatous habit, lacking taproots, of *Oxalis stricta* and its close relatives *O. grandis* and *O. illinoensis* is distinctive and a basic biological difference. The bases of *Oxalis* plants often are incompletely collected, however, especially in the other species, which commonly develop stoloniform or rhizomiform branches above the taproot.

Oxalis stricta in western states is uncommon and probably adventive. Reports of the species from Texas (e.g., USDA, NRCS 2009) have not been confirmed in the present study and it is unlikely that such reports are accurate. The early establishment of *O. stricta* in Europe is noted above with the type of *O. europaea*. Eiten (1963) appeared to suggest that the species may be native in eastern Asia as well as North America.

Eiten's comments (1963, p. 304–305) on variability in the species are insightful and repeated here: "Very variable, both as between east Asia and North America, and within each region. I have not seen enough material from east Asia to determine if it is useful to set up subspecies. In North America all the variation that is regionally based is too intergrading to set up useful infraspecific categories. The most distinctive geographically-based character is the presence of hairs on the upper surface of the leaflets. This is most frequent in the Midwest, but even there less than half the collections in each state have this feature, and sometimes it varies even within single populations. This and other characters that have been used to set up infraspecific groups (presence of septate hairs on stems or on pedicels) often vary in the same population or even on the same plant, and present all intergrades of expression. In addition, the extreme expressions of characters that vary regionally center in different areas, i.e., they do not vary together. The introduced European plants represent a small part of the North American variation, in general being less pubescent. They are not at all like the plants of east Asia."

7. Oxalis grandis Small, Bull. Torrey Bot. Club 21:475. 1894. *Xanthoxalis grandis* (Small) Small, Fl. S.E. U.S. 668. 1903. Type: U.S.A. Pennsylvania. [Bradford Co.]: Wysox, Jul 1836, *J. Carey s.n.* (lectotype, Eiten 1963: NY, NY-digital image!; isolectotype: GH!).

Oxalis recurva Trel., Mem. Boston Soc. Nat. Hist. 4:89. 1888 (not Elliott 1821). Fide Wiegand (1925).

Plants perennial, caulescent, arising from slender, lignescent, stoloniform rhizomes without tubers. **Stems** erect, usually single from the base (rarely 2–3 together), (10–)25–60(–100) cm before branching, nearly glabrous to sparsely or densely pilose or villous with a mixture of septate and nonseptate hairs. **Stipules** absent. **Leaves** cauline, mostly on the distal half of the stem; leaflets 3, obcordate, lobed 1/5 length, 5–25(–30) mm, upper shoulders of lobes usually rounded, rarely flattened, green on both surfaces, margins sometimes narrowly brownish-purple, ciliate, petioles 5–7.5 cm. **Flowers** 1 or 2–4(–8) in regular or irregular cymes or umbelliform cymes produced above the level of the leaves, tristylous; peduncles 7–12 cm; pedicels in fruit erect to ascending; petals 10–14 mm, yellow, throat yellow to faintly or weakly red-lined within. **Capsules** ovoid to ovoid-oblong, 6–10 mm long. **Seeds** brown, traverse ridges rarely whitish. $2n = 28$ (fide Weller & Denton 1976, reporting unpublished counts by Ornduff).

Flowering May–Aug. Sandy woods and alluvial soils; 100–1100 m. Ala.!, D.C.!, Ga.!, Ind.!, Ky.!, Md.!, N.C.!, Ohio.!, Penn.!, S.C.!, Tenn.!, Va.!, W.Va.!

A report of *Oxalis grandis* from southern Mississippi (Forrest Co.; Carter & Jones 1968) is far out of range and habitat for the species and probably is based on a misidentification, perhaps of *O. priceae*, which also is large-flowered.

8. Oxalis illinoensis Schwegm., Phytologia 50:467. 1982. Type: U.S.A. Tennessee. Macon Co.: by Tenn. [Hwy] 10, S side of and below Lafayette, steep, deep hardwood ravine, clay loam, 5 May 1975, *R. Kral 55218* (neotype, designated here: MO!; isoneotype: VDB!). The neotype and isoneotype clearly show the diagnostic features of the rhizome and inflorescence. Alas, the collection is not from Illinois, but the geographically geometric center of the range is in eastern Kentucky and the species barely occurs in Illinois (comments below). The holotype was deposited at SIU but cannot now be located there and is presumed to have been destroyed: Illinois. Pope Co.: Wooded floodplain forest along Little Lusk Creek at Martha's Woods, 4 miles ENE of Eddyville, 11 May 1968, *J.E. Schwegman 1661*.

Plants perennial, caulescent, arising from slender, herbaceous rhizomes at intervals producing white fusiform tubers or tuberlike thickenings. **Stems** erect, usually single from the base (rarely 2–3 together), 15–40 cm, nearly glabrous or sparsely to densely villous with a mixture of septate and nonseptate hairs. **Stipules** obsolescent, without free margins or apical auricles. **Leaves** cauline; leaflets 3, obcordate, lobed 1/5 length, (12–)20–30(–35) mm, upper shoulders of lobes flat, green on both surfaces, margins green, ciliate, petioles 4–7.5 cm long. **Flowers** 1–3(–6) in regular or irregular cymes produced mostly at the level of the leaves, tristylous; peduncles 3–10 cm, pedicels in fruit erect to ascending; petals 12–18 mm, yellow, throat strongly red-lined within. **Capsules** oblong-ovoid, 7–10 mm. **Seeds** brown, traverse ridges rarely whitish. $2n$ = unknown.

Flowering Apr–Sep. Slopes, bluffs, ravines, floodplains, mesic forests, sometimes forming the dominant ground cover, commonly on limestone, shale, or calcareous loess substrate; 200–500 m; s Ill.!, s Ind.!, w Ky.!, and c Tenn.!

Differences between *Oxalis illinoensis* and *O. grandis* are subtle but they appear to be correlated with geography; the tuberous portions of the *O. illinoensis* rhizomes are diagnostic but they commonly are broken off during collection. *Oxalis illinoensis* apparently occupies the western part of the range of *O. grandis* sensu lato; the two species appear to be closely contiguous (non-overlapping or barely overlapping) in range in Tennessee (Univ. of Tennessee Herbarium 2008; personally confirmed by study of many collections at BRIT/VDB and MO). Michael Homoya (pers. comm.), of the Indiana Dept. of Natural Resources, observes that the two species overlap in range in southern Indiana, where they are mostly separated by habitat, with "*Oxalis grandis* on the drier, more acidic slopes, and *O. illinoensis* in the mesic, alkaline environments." *Oxalis illinoensis* in Illinois is known from only three counties immediately bordering Indiana and Kentucky, and is state-listed as endangered (S1, Illinois Endangered Species Protection Board 1999). John Schwegman (pers. comm.) observes that he has never seen *O. grandis* in Illinois, nor have I seen any collections (MO). County-level distribution records in Indiana and Kentucky shown by USDA, NRCS (2008) need to be reexamined.

Medley (1993) has observed that *Oxalis illinoensis* and *O. grandis* intergrade, and a hybrid population is said to exist in Indiana (Heikens 2003, citing unpublished and undocumented observations by S. Olson).

ACKNOWLEDGMENTS

I am grateful to the staffs at BRIT-SMU-VDB, GH-NEBC, MO, NLU, and TEX-LL for help during visits to those herbaria and ASU for a loan of specimens of sect. *Corniculatae* to MO. Kanchi Gandhi and Jim Reveal gave advice on typification of *Oxalis dillenii*, Nancy Elder (Librarian, Univ. of Texas Life Science Library) provided literature relevant to the typification (or lack of it) of *O. europaea*. Michael Homoya (Indiana Dept. of Natural Resources), John Schwegman, Steve Hill, and Bob Mohlenbrock provided information on *O. illinoensis*, Gene Wofford provided information and an image of the collection of *O. priceae* from Cocke Co., Tennessee, and Carol McCormick for help with selecting a neotype for *Oxalis lyonii*. George Yatskievych, Kay Yatskievych, Gordon Tucker, Bruce Sorrie, Alan Weakley, and Dan Ward reviewed the key and manuscripts and gave helpful comments. Comments and critique by Jim Henrickson have sharpened the focus of definitions of species in this group. Steve Hill and an anonymous reviewer provided useful critiques for the journal review. This study was done as part of the work under contract for the Flora of North America Association in conjunction with preparation of the FNA treatment of *Oxalis*.

REFERENCES

Abrams, L. 1951. Illustrated flora of the Pacific States, Washington, Oregon, California. Vol. III. Stanford Univ. Press, Stanford, Calif.

Ascherson, P. and P. Graebner. 1913. Synopsis der mitteleuropaïschen Flora, Vol 7. Verlag von Wilhelm Engelmann, Leipzig.

Carter, J.W., Jr., and S.B. Jones. 1968. The vascular flora of Johnson State Park, Mississippi. Castanea 33:194–205.

Druce, G.C. and S.H. Vines. 1907. The Dillenian herbaria. Clarendon Press, Oxford.

Eiten, G. 1955. Typification of the names "*Oxalis corniculata* L." and "*Oxalis stricta* L." Taxon 4:99–105.

Eiten, G. 1963. Taxonomy and regional variation of *Oxalis* section *Corniculatae*, I. Introduction, keys and synopsis of the species. Amer. Midl. Naturalist 69:257–309.

Ewan, J. and N. Ewan. 1963. John Lyon, nurseryman and plant hunter and his journal, 1799–1814. Trans. Amer. Philos. Soc. 53:1–69.

Heikens, A.L. 2003. Conservation Assessment for Illinois Wood-Sorrel (*Oxalis illinoensis* Schwegm.). USDA Forest Service, Eastern Region. <http://www.fs.fed.us/r9/wildlife/tes/ca-overview/docs/ Plants/Illinois%20Woodsorrel.pdf>

Jarvis, C.E. 2007. Order out of chaos: Linnaean plant names and their types. Linnean Society of London in association with the Natural History Museum, London.

de Lange, P.J., R.O. Gardner, W.R. Sykes, G.M. Crowcroft, E.K. Cameron, F. Stalker, M.L. Christian, and J.E. Braggins. 2005. Vascular flora of Norfolk Island: some additions and taxonomic notes. New Zealand J. Bot. 43:563–596.

Lourteig, A. 1979. Oxalidaceae extra-austroamericanae: 2. *Oxalis* L. Sectio *Corniculatae* DC. Phytologia 42: 57–198.

Lovett Doust, L., J. Lovett Doust, and P.B. Cavers. 1981. Fertility relationships in closely related taxa of *Oxalis* section *Corniculatae*. Canad. J. Bot. 59:2603–2609.

Medley, M.E. 1993. An annotated catalog of the known or reported vascular flora of Kentucky. Ph.D. Diss., Univ. of Louisville, Kentucky.

Mulcahy, D.M. 1964. The reproductive biology of *Oxalis priceae*. Amer. J. Bot. 51:1045–1050.

Nair, B.R. and P. Kuriachan. 2004. Cytogenetic evidence of the evolution of *Oxalis corniculata* var. *atropurpurea* Planch. Cytologia 69:149–153.

Reveal, J.L. 1983. Significance of pre-1753 botanical explorations in temperate North America on Linnaeus' first edition of Species Plantarum. Phytologia 53:1–96.

Robinson, B.L. 1906. *Oxalis corniculata* and its allies. J. Bot. 44:386–391.

Schwegman, J.E. 1982. A new species of *Oxalis*. Phytologia 50:463–467.

Small, J.K. 1898. Studies in the botany of the southeastern United States.—XV. Bull. Torrey Bot. Club 25: 605–621.

Small, J.K. 1903. Flora of the southeastern United States. Published by the author, New York.

Small, J.K. 1907. Oxalidaceae. North American flora 25:25–58.

Turner, B.L. 1994. Regional variation in the North American elements of *Oxalis corniculata* (Oxalidaceae). Phytologia 77:1–7.

Turner, B.L., H. Nichols, G.C. Denny, and O. Doron. 2003. Atlas of the Vascular Plants of Texas, Vol. 2. Sida, Bot. Misc. No. 24.

University of Tennessee Herbarium (TENN). 2008. Database of Tennessee Vascular Plant Occurences. <http://tenn.bio.utk.edu/vascular/vascular.shtml>

USDA, NRCS. 2008. The PLANTS Database (http://plants.usda.gov, 31 October 2008). National Plant Data Center, Baton Rouge, Louisiana.

Ward, D.B. 2004. Keys to the flora of Florida–9, *Oxalis* (Oxalidaceae).

Watson, M.F. 1989. Nomenclatural aspects of *Oxalis* section *Corniculatae* in Europe. Bot. J. Linn. Soc. 101: 347–362.

Weller, S.G. and M.F. Denton. 1976. Cytogeographic evidence for the evolution of distyly from tristyly in the North American species of *Oxalis* section *Ionoxalis*. Amer. J. Bot. 63:120–125.

Wiegand, K.M. 1925. *Oxalis corniculata* and its relatives in North America. Rhodora 27:113–124, 133–139.

Young, D.P. 1958. *Oxalis* in the British Isles. Watsonia 4:51–69.

CLARIFICATION OF THE TYPIFICATION OF MICHAUX NAMES IN EASTERN NORTH AMERICAN *VITIS* (VITACEAE)

Connie Fisk
Department of Horticultural Science
North Carolina State University
Raleigh, North Carolina 27695-7609, U.S.A.
Connie_Fisk@ncsu.edu

Alexander Krings
Department of Plant Biology
North Carolina State University
Raleigh, North Carolina 27695-7612, U.S.A.
Alexander_Krings@ncsu.edu

ABSTRACT

The typification ascriptions of the four Michaux names in eastern North American *Vitis* are clarified given the confusion in the literature: *V. aestivalis*, *V. cordifolia*, *V. riparia*, and *V. rotundifolia*.

RESUMEN

Las adscripciones de tipificación de los cuatro nombres de *Vitis* de Michaux en el este de Norte América se clarifican dada la confusión en la bibliografía: *V. aestivalis*, *V. cordifolia*, *V. riparia*, y *V. rotundifolia*.

Uttal (1984) typified a large number of Michaux names for North American plants, including several in eastern North American *Vitis* L. (Vitaceae). Uttal provided a citation for each name that indicated the card number in the IDC microfiche set of the Michaux herbarium (IDC 1967) and the photo number on the card in which the selected element appeared. Uttal noted that: "[…] each such designation is equivalent to the selection of the specimen photographed as the holotype, if single, or lectotype if one of a series" (p. 5). However, he referred to the specimens only as "Type." Unfortunately, this leaves readers to speculate as to whether Uttal considered a given cited specimen as a holotype or a lectotype. Fortunately, Art. 9.8 of the International Code of Botanical Nomenclature (ICBN; McNeill et al. 2006) allows for the correction of the mistaken use of a term for type, thus Uttal's use of the term "Type," abbreviated throughout his paper to "T," is an error correctable to "Lectotype." In 1991, Moore indicated lectotypes for the same Michaux names in *Vitis*, incorrectly labeling each as "here designated." It remains unclear whether Moore (1991) was unaware of Uttal's work (it was not cited) or whether he felt the ambiguity between the categories holo- and lectotype needed correction. In either case, unless demonstrably incorrect, Uttal's typifications have priority and must be followed according to Art. 9.17 of the ICBN (McNeill et al. 2006). However, because the typifications of both Uttal and Moore do not coincide in all cases and as errors (regardless whether made by printer or author) are found in each, we seek to clarify the typification ascriptions of the four Michaux names in eastern North American *Vitis*. The typification statements of both Uttal and Moore are shown. The accepted typification is bolded.

Vitis aestivalis Michx., Fl. Bor.-Amer. 2:230. 1803.

Uttal (1984, p. 62): Lectotype (as "Type"): *a pensylvania ad Carolinam* ; P, IDC Michaux, microfiche no. 122, photo 17!
Moore (1991): same lectotype designated as Uttal (1984).

Vitis cordifolia Michx., Fl. Bor.-Amer. 2:231. 1803. [=*V. vulpina* L.]

Uttal (1984, p. 62): Lectotype (as "Type"): *Hab. a Nova Anglia ad Carolinam* P, IDC Michaux, microfiche no. 123, photo 3!
Moore (1991): same lectotype designated as Uttal (1984).

Vitis riparia Michx., Fl. Bor.-Amer. 2:231. 1803.

Uttal (1984): "Type": "*ad ripas et in inusulis fluviorum Ohio, Misissipi, etc.*": P, IDC Michaux, microfiche no. 122, photo 20!
Moore (1991, p. 361): Lectotype (as "Holotype"): "*ad ripas et in insulis fluviorum Ohio, Mississippi, etc.*": P, IDC microfiche no. 122, photo 19!, bottom specimen!

Photo 20 of fiche 122 contains no specimens, only labels and descriptive information for the specimens in photo 19, including a label dated 1897 ("the two upper specimens seem to be *Vitis rupestris* Scheele") and four labels for "*Vitis riparia*." Uttal's type citation for *V. riparia* (i.e., fiche 122, photo 20) includes only the label of the corresponding specimen cited by Moore as the holotype (here corrected to lectotype). The label reads: "ad ripas et insulas, Ohio, Misissipi."

Vitis rotundifolia Michx., Fl. Bor.-Amer. 2:231. 1803.

Uttal (1984, p. 62): Lectotype (as "Type"): [*Hab. a Virginia ad Floridam*] P, IDC Michaux, microfiche no. 122, photo 21!

Moore (1991): "Lectotype": *a Virginia ad Floridum*: P, IDC Michaux, microfiche no. 122, photo 20!

Uttal designated the element in photo 21 of fiche 122 as the type of *V. rotundifolia*. Because his study concentrated on the entire fiche set, we reasonably assume that Uttal was aware that *V. rotundifolia* was also represented by another specimen (fiche 123, photo 1). His selection of the element on fiche 122, photo 21, as the "type" (here corrected to lectotype) was a good choice as it is a better specimen, clearly showing the unbranched tendrils unique to subgenus *Muscadinia* (Planch.) Rehder in eastern North America. We interpret Moore's designation of photo "20" as an inadvertent printing error, since he was obviously aware that this photo included only labels for elements mounted on another sheet (as evidenced by his careful discrimination among elements in the case of *V. riparia*; see above). He accepted photo 1, fiche 123 as a syntype.

ACKNOWLEDGMENTS

We thank Fred Barrie, Eric Wada, and an anonymous reviewer for constructive comments improving this manuscript.

REFERENCES

Inter Documentation Company. 1967. Microfiche set of the Herbarium of A. Michaux, *Flora boreali-americana*. Zug, Switzerland. 6211:122–123.

McNeill, J., F.R. Barrie, H.M. Burdet, V. Demoulin, D.L. Hawksworth, K. Marhold, D.H. Nicolson, J. Prado, P.C. Silva, J.E. Skog, J.H. Wiersema, and N.J. Turland. 2006. International code of botanical nomenclature (Vienna code). Regnum Veg. 146, A.R.G. Ganter Verlag KG.

Michaux, A. 1803. *Vitis*. Fl. Bor.-Amer. 2:230–231.

Moore, M.O. 1991. Classification and systematics of eastern North American *Vitis* L. (Vitaceae) north of Mexico. Sida 14:339–367.

Uttal, L.J. 1984. The type localities of the Flora Boreali-Americana of André Michaux. Rhodora 86:1–65.

ADDITIONAL MORPHOLOGICAL MEASUREMENTS OF *ARCEUTHOBIUM SISKIYOUENSE* AND *A. MONTICOLA* (VISCACEAE)

Robert L. Mathiasen
School of Forestry
Northern Arizona University
Flagstaff, Arizona 86011, U.S.A.
Robert.Mathiasen@nau.edu

Carolyn M. Daugherty
Department of Geography, Planning, and Recreation
Northern Arizona University
Flagstaff, Arizona 86011, U.S.A.
Carolyn.Daugherty@nau.edu

ABSTRACT

Additional morphological measurements were collected for *Arceuthobium siskiyouense* from a total of 15 locations in southwestern Oregon and northwestern California. Measurements were made for male and female plants growing on *Pinus attenuata*, *P. jeffreyi*, and *P. contorta* var. *contorta*. Characters measured were similar on all three hosts, but plant size was largest on *P. jeffreyi* and smallest on *P. contorta* var. *contorta*. Additional morphological measurements were also collected for *A. monticola*, another endemic dwarf mistletoe of the Klamath/Siskiyou Mountains. Results demonstrated that *A. siskiyouense* is morphologically similar to *A. campylopodum* and that *A. monticola* is morphologically similar to *A. californicum*. Our measurements for flower characteristics are the first reported for *A. siskiyouense* and *A. monticola*.

Key Words: *Arceuthobium monticola, Arceuthobium siskiyouense,* morphology, *Pinus attenuata, Pinus contorta* var. *contorta, Pinus jeffreyi, Pinus monticola*

RESUMEN

Se reportan nuevas mediciones morfológicas de *Arceuthobium siskiyouense* de un total de 15 sitios en el suroeste de Oregón y noroeste de California. Las mediciones se hicieron sobre plantas masculinas y femeninas creciendo sobre *Pinus attenuata, P. jeffreyi*, y *P. contorta* var. *contorta*. Los caracteres medidos fueron similares en las plantas sobre todos los hospederos, pero el tamaño de la planta fue mayor sobre *P. jeffreyi* y más pequeño sobre *P. contorta* var. *contorta*. También se reportan mediciones adicionales sobre *A. monticola*, otro muérdago enano endémico de las Montañas Klamath/Siskiyou. Los resultados muestran que *A. siskiyouense* es morfológicamente similar a *A. campylopodum* y que *A. monticola* es morfológicamente similar a *A. californicum*. Nuestras mediciones de las características de las flores son las primeras que se reportan tanto para *A. siskiyouense* como para *A. monticola*.

Palabras Clave: *Arceuthobium monticola, Arceuthobium siskiyouense,* morfología, *Pinus attenuata, Pinus contorta* var. *contorta, Pinus jeffreyi, Pinus monticola*

Arceuthobium siskiyouense Hawksw., Wiens & Nickrent (Knobcone pine dwarf mistletoe, Viscaceae) and *A. monticola* Hawksw., Wiens & Nickrent (western white pine dwarf mistletoe) are endemic to the Klamath/Siskiyou Mountains of northwestern California and southwestern Oregon (Hickman 1993; Hawksworth & Wiens 1996). Prior to 1992, *A. siskiyouense* was classified as *A. campylopodum* Engelm. and *A. montiolca* was grouped with *A. californicum* Hawksw. & Wiens. Hawksworth et al. (1992) separated *A. siskiyouense* from *A. campylopodum* based on differences in plant and fruit size, flowering period, host affinities, and the inducement of witches' brooms or not on infected principal hosts (see their Table 1). They separated *A. monticola* from *A. californicum* based on plant and fruit size, plant color, seed dispersal period, and host affinities (see their Table 2). An electrophoretic analysis of isozymes also supported the separation of *A. siskiyouense* from *A. campylopodum* and *A. monticola* from *A. californicum* (Nickrent & Butler 1991). However, recent molecular work has demonstrated that these taxa are closely related and that further study of their morphological and physiological characteristics was needed (Nickrent et al. 2004). Because *A. siskiyouense* commonly parastizes *Pinus attenuata* Lemm., *P. jeffreyi* Grev. & Balf., and *P. contorta* Dougl. ex Loud. var. *contorta* within its geographic range (Mathiasen & Daugherty 2009), we collected additional morphological data for this dwarf mistletoe from each of these hosts. We also collected additional morphological data for *A. monticola* because little was known regarding its flower and fruit morphology (Hawksworth & Wiens 1996). This allowed us to compare morphological characteristics of *A. siskiyouense* and *A. monticola* with *A. campylopodum* and *A. californicum*, respectively, using plant and flower characteristics for all four species.

J. Bot. Res. Inst. Texas 3(2): 741 – 749. 2009

MATERIALS AND METHODS

In order to make a comparison of the morphological characters of *Arceuthobium siskiyouense* on its pine hosts we sampled 15 populations of the mistletoe (Fig. 1). Plants were collected from *Pinus attenuata* only (3 locations); from *P. jeffreyi* only (2 locations); from both *P. attenuata* and *P. jeffreyi* (6 locations); and from both *P. attenuata* and *P. contorta* var. *contorta* (4 locations). Five populations of *Arceuthobium monticola* were sampled; 2 in southwestern Oregon and 3 in northwestern California (Fig. 1). Plants were measured from the type localities for both dwarf mistletoes (Fig. 1; locations 5 and 6; Hawksworth et al. 1992). Identification of host trees was based on Hickman (1993) and Critchfield (1980) for *P. contorta* var. *contorta*.

From each population, 10–20 male and 10–20 female infections were collected and the dominant shoot from each infection was used for morphological measurements. The dwarf mistletoe plant characters measured were those used by Hawksworth and Wiens (1996) for taxonomic classification of *Arceuthobium* spp. The following morphological characters were measured: 1) height, basal diameter, third internode length and width, and color of male and female plants; 2) mature fruit length, width, and color; 3) seed length, width and color; 4) length and width of staminate spikes; 5) staminate flower diameters for 3- and 4-merous flowers; 6) length and width of staminate flower perianth lobes; and 7) anther diameter and anther distance from the perianth lobe tip. Plants were measured within 24 hours after collection and were measured using a digital caliper, a dissecting microscope with a micrometer, or with a 7× hand lens equipped with a micrometer. Staminate spike and flower measurements were made during the peak of anthesis and fruit and seed measurements were made during the peak of seed dispersal.

Because the times of flowering and seed dispersal for both dwarf mistletoes were poorly known (Hawksworth & Wiens 1996), additional observations of the phenology of these taxa were made during the summer and fall of 1998, 2003, 2004, 2007, and 2008.

RESULTS AND DISCUSSION

Arceuthobium siskiyouense

Plant heights for male and female plants on the pine hosts of *Arceuthobium siskiyouense* were similar, but plants were slightly smaller from *Pinus contorta* and slightly larger from *P. jeffreyi* when compared to those measured on *P. attenuata* (Table 1). The means and ranges for basal diameters and third internode dimensions were also similar for male and female plants from the different pine hosts. Flower characteristics were also similar, but the diameter of 3-merous flowers was smaller by 0.2–0.3 mm from male plants growing on *P. contorta* (Table 1). Fruit and seed sizes followed the same pattern as plant heights; fruits and seeds were largest on average from *P. jeffreyi* and smallest from *P. contorta*. Plant color of both male and female plants ranged from dark brown to red-brown to brown-green, independent of the host from which they were sampled. The dark brown to red-brown color of plants was the principal characteristic used to identify *A. siskiyouense* at two locations where there were no infected *P. attenuata* growing near infected *P. jeffreyi* (Fig. 1, locations 7 and 19).

The mean size of plants reported by Hawksworth et al. (1992) when they described *A. siskiyouense* was similar to what we obtained, but we measured plants on *P. attenuata* that were larger (15 cm) than they reported (10 cm). We also found that the basal diameters and third internode dimensions of *A. siskiyouense* plants were slightly larger than those reported by Hawksworth el al. (1992). Results also indicate that the size of fruits of *A. siskiyouense* was larger (5.1 × 3.3 mm) than reported by Hawksworth et al. (1992) for this species (4.0 × 2.5 mm) or by Hawksworth and Wiens (1996) (3.6 × 2.1 mm).

The results of our morphological measurements for *Arceuthobium siskiyouense* demonstrate that this species is morphologically very similar to *A. campylopodum* (Table 2). The latter taxon originally encompassed *A. siskiyouense* before Hawksworth et al. (1992) separated the dwarf mistletoe populations parasitizing *Pinus attenuata* in northwestern California and southwestern Oregon at the specific level. Based on our measurements of *A. siksiyouense*, the size of plants, flowers, and fruits are only slightly larger than those of *A. campylopodum*; the primary morphological difference between these species being plant color. *Arceuthobium siskiyouense* is

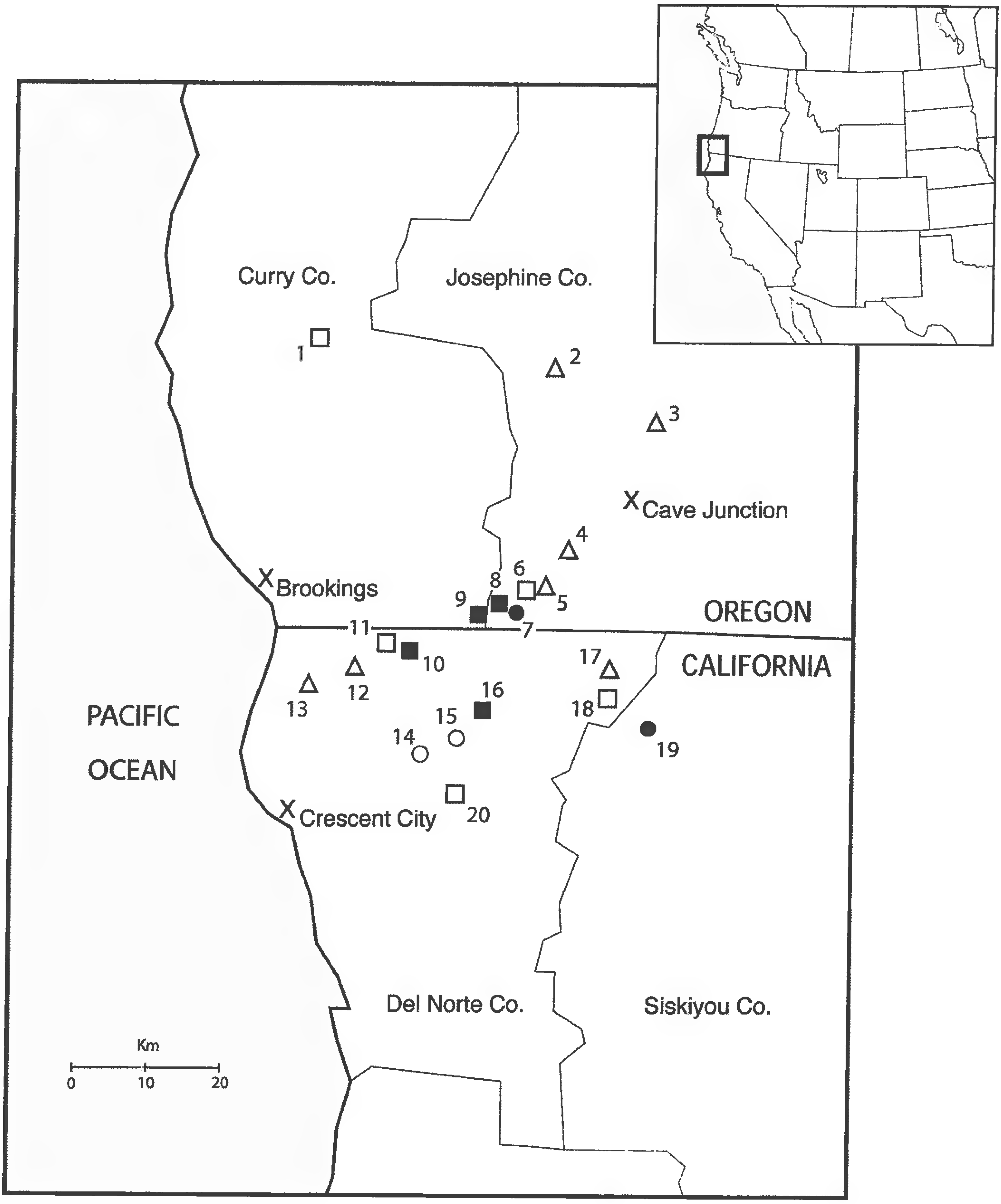

Curry Co.
Josephine Co.
Cave Junction
Brookings
OREGON
CALIFORNIA
PACIFIC
OCEAN
Crescent City
Del Norte Co.
Siskiyou Co.
Km
0
10
20
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

Fig. 1. Approximate location of collection sites in California and Oregon. **Open triangles** represent locations where *Arceuthobium siskiyouense* was collected and measured on *Pinus attenata* and *P. jeffreyi*. **Open circles** represent locations where *A. siskiyouense* was collected and measured on *P. attenuata* only. **Dark squares** represent locations where *A. siskiyouense* was collected and measured on *P. attenuata* and *P. contorta* var. *contorta*. **Dark circles** represent locations were *A. siskiyouense* was collected and measured only on *P. jeffreyi*. **Open square** represent locations where *A. monticola* was collected and measured on *P. monticola*. Numbers correspond to the following locations: 1–Snowcamp Mountain; 2–Chrome Ridge; 3–Lookout Gap; 4–Rock Creek on Oregon Mountain Road; 5–Type locality for *A. siskiyouense* on Oregon Mountain Road; 6–Type locality for *A. monticola* on Oregon Mountain Road; 7–Oregon Mountain; 8–Bain Station; 9–3 km southwest of Bain Station; 10–Smith River Bridge; 11–Sourdough Junction; 12–Pine Flat Mountain; 13–High Divide; 14–Old Gasquet Toll Road, near Danger Point; 15–Old Gasquet Toll Road, Elevenmile Creek; 16–Old Gasquet Toll Road, Twelvemile Creek; 17–5 km north of Black Butte; 18–Black Butte; 19–Bear Gulch; 20–Ship Mountain.

Table 1. Morphological measurements for *Arceuthobium siskiyouense* on *Pinus attenuata*, *P. jeffreyi*, and *P. contorta* var. *contorta*. Data are listed as mean (range) [n]. Letters in brackets designate sample sizes already listed in the same column. Plant heights in cm and all other measurements in mm.

Character	*Pinus attenuata*	*Pinus jeffreyi*	*Pinus contorta* var. *contorta*
Plant Height			
Male	8.1 (5.1–15.2) [120a]	8.3 (5.1–14.7) [100a]	7.7 (5.0–13.9) [60a]
Female	8.9 (5.3–14.8) [160b]	9.3 (5.8–17.3) [120b]	8.7 (5.7–14.1)[a]
Basal Diameter			
Male	3.0 (1.8–4.3) [a]	3.1 (2.4–6.1) [a]	2.9 (2.1–5.1) [a]
Female	2.9 (1.9–5.7) [b]	3.2 (2.4–5.9) [b]	3.0 (1.9–4.9) [a]
Length of Third Internode			
Male	11.7 (7.1–22.3) [a]	12.8 (7.5–22.9) [a]	11.3 (6.3–21.2) [a]
Female	12.5 (7.4–22.8) [b]	14.7 (7.5–25.4) [b]	12.7 (5.8–20.7) [a]
Width of Third Internode			
Male	2.0 (1.5–2.8) [a]	2.2 (1.6–3.0) [a]	1.9 (1.2–2.8) [a]
Female	1.9 (1.3–3.0) [b]	2.1 (1.6–3.0) [b]	1.9 (1.4–2.8) [a]
Staminate Spike Length	11.1 (6.0–17.3) [200c]	12.4 (5.2–19.1) [160c]	10.5 (6.2–15.8) [100b]
Staminate Spike Width	1.9 (1.5–2.4) [c]	2.0 (1.6–2.6) [c]	1.9 (1.4–2.3) [b]
Mean Flower Diameter			
3-merous	3.2 (2.6–3.9) [100d]	3.3 (2.7–3.8) [50d]	3.0 (2.5–3.7) [50c]
4-merous	4.4 (3.7–5.6) [d]	4.5 (3.7–5.9) [d]	4.4 (3.6–5.5) [c]
Perianth Lobe Length	1.5 (1.2–1.9) [c]	1.5 (1.1–2.0) [a]	1.5 (1.1–1.8) [b]
Perianth Lobe Width	1.5 (1.2–2.1) [c]	1.4 (1.1–1.9) [a]	1.4 (1.0–2.0) [b]
Anther Diameter	0.8 (0.5–1.1) [c]	0.7 (0.4–1.1) [a]	0.8 (0.5–1.2) [b]
Anther Distance from Tip	0.8 (0.5–1.1) [c]	0.8 (0.4–1.1) [a]	0.7 (0.4–1.0) [b]
Mean Fruit Length (mm)	5.1 (4.1–6.1) [110e]	5.3 (4.0–6.0) [80e]	4.9 (3.8–5.7) [c]
Mean Fruit Width (mm)	3.3 (2.6–4.1) [e]	3.5 (2.8–4.3) [e]	3.1 (2.5–3.8) [c]
Seed Length	3.0 (2.1–4.0) [e]	3.1 (2.0–3.9) [e]	2.9 (2.1–2.8) [c]
Seed Width	1.3 (1.0–1.8) [e]	1.3 (0.9–1.9) [e]	1.2 (0.8–1.8) [c]

consistently dark brown, red-brown, or brown-green, and we did not observe any male or female plants of this mistletoe that we considered yellow, a plant characteristic described for *A. campylopodum*. However, we did observe a few male plants of *A. siskiyouense* that were brown-green and it is difficult to determine if our use of brown-green to designate plant color is different from the olive-green designation used by Hawksworth and Wiens (1972, 1996) for *A. campylopodum*. It was also difficult to compare plant dimensions between these species because Hawksworth et al. (1992, Table 1) and Hawksworth and Wiens (1996, Table 16.6) indicate the height of plants of *A. campylopodum* as averaging 12 cm with a range from 10–14 cm. However, they describe *A. campylopodum* plants as averaging about 8 cm in height with a maximum height of 13 cm in their written descriptions of the species (Hawksworth & Wiens 1972, 1996). We chose to adopt their written descriptions of *A. campylopodum* for our comparisons with *A. siskiyouense* in Table 2.

The mean diameter of 3-merous flowers for *A. siskiyouense* and *A. campylopodum* was similar also (3.2 and 3.0 mm, respectively), but Hawksworth et al. (1992) and Hawksworth and Wiens (1996) did not provide a range for flower diameters of either species. Our flower measurements indicate the width of perianth lobes and anther diameters were smaller for *A. campylopodum* when compared to *A. siskiyouense* (Table 2), but other flower characteristics were similar for these taxa.

The mean dimensions of fruits of *A. siskiyouense* we obtained (5.1 × 3.3 mm) were approximately the same size as the fruits of *A. campylopodum* when information for this character reported in the descriptions of *A. campylopodum* in Hawksworth and Wiens (1972, 1996) is used (5.0 × 3.0 mm). But fruit dimensions

Table 2. Comparison of morphological characters between *Arceuthobium siskiyouense* and *A. campylopodum*. Morphological measurements for *A. siskiyouense* are combined from all hosts. Data for *A. campylopodum* are from Hawksworth and Wiens (1996, page 199). Single numbers in columns are means as no range information was available for *A. campylopdum*. Plant heights in cm and all other measurements in mm.

Character	*Arceuthobium siskiyouense*	*Arceuthobium campylopodum*
Plant Height[a]	8.7 (5–17)	8.0 (Maximum - 13)
Basal Diameter[a]	3.0 (1.8–6.1)	3.0 (1.5–5.0)
Length of Third Internode [a]	12.9 (6–25)	11.3 (7–22)
Width of Third Internode [a]	2.0 (1.2–3.0)	2.0 (1.5–2.5)
Plant Color	Dark brown, brown-green, red-brown	Olive-green, yellow
Mean Flower Diameter [b]	3.2	3.0
Perianth Lobe Length	1.5	1.4
Perianth Lobe Width	1.5	1.1
Anther Diameter	0.8	0.5
Anther Distance from Tip	0.8	0.8
Mean Fruit Length	5.1	5.0
Mean Fruit Width	3.3	3.0

[a] – Male and female plants combined.
[b] – 3-merous flowers.

of *A. campylopodum* have also been reported as large as 6.0 × 3.5 mm in Hawksworth et al. (1992, Table 1) and 5.6 × 3.0 mm in Hawksworth and Wiens (1996, Table 16.6). Therefore, it was difficult to compare not only plant dimensions for these dwarf mistletoes, but fruit dimensions as well. Nevertheless, when our measurements of characters for *A. siskiyouense* are compared with the written descriptions, it is evident these dwarf mistletoes are morphologically more similar than reported by Hawksworth et al. (1992). A more detailed morphological analysis is needed for *A. campylopodum*, as well as for other closely related California taxa such as *A. occidentale* Engelm. and *A. littorum* Hawksw., Wiens & Nickrent. The latter species are also morphologically similar to *A. campylopodum* as are their hosts, phenology, and molecular characteristics (Nickrent & Butler 1990; Hawksworth et al. 1992; Hawksworth & Wiens 1996; Nickrent et al. 2004).

Although Hawksworth et al. (1992) reported that *A. siskiyouense* did not induce the formation of witches' brooms on infected *Pinus attenuata*, our observations indicate that it frequently does form brooms on this host (Mathiasen and Daugherty 2009). Host susceptibility was also used by Hawksworth et al. (1992) to separate *A. siskiyouense* from *A. campylopodum*; *A. siskiyouense* rarely infecting both *P. jeffreyi* and *P. ponderosa* Laws., both of which are principal hosts of *A. campylopodum*. However, *A. campylopodum* commonly infects *P. attenuata*, the principal host of *A. siskiyouense*, and the latter species has now been shown to commonly parasitize *P. jeffreyi* (Mathiasen & Daugherty 2009).

Anthesis of *Arceuthobium siskiyouense* begins in late-July, peaks in mid-August, and continues into early-September. In every year we observed flowering for this mistletoe, it had completed flowering by late-September. Seed dispersal of *A. siskiyouense* begins in late-September and peaks in mid- to late-October. It continues into early-November, but we were not able to determine when seed dispersal is completed for this species. Our observations of seed dispersal for *Arceuthobium siskiyouense* agree with those reported by Hawksworth et al. (1992), but our observations of flowering indicate its peak flowering period is in August rather than in September.

Based on the morphological data presented here, the overlap in physiological characteristics of *Arceuthobium siskiyouense* with *A. campylopodum* (phenology and host affinities), and the molecular data available thus far (Nickrent et al. 2004), the classification of the dwarf mistletoe populations parasitizing *P. attenuata* in the Klamath/Siskiyou Mountains as a subspecies of *A. campylopodum* may be more representative of the phylogenetic relationships of these mistletoes. Our data indicate that there are a few morphological discontinuities between *A. siskiyouense* and *A. campylopodum* and Nickrent and Butler (1991) found genetic differences between these taxa based on their isozyme analysis. However, until we collect additional morphological, host infection, phenology, and distribution data for *A. campylopodum* throughout its geographic range, we feel it would be inappropriate to recombine *A. siskiyouense* as a subspecies of *A. campylopodum* here. Furthermore, subspecies of *Arceuthobium* are usually geographically isolated (Hawksworth and Wiens 1996) and thus far we are uncertain to what degree the geographic range of these two mistletoes does or does not overlap, even though the distribution maps in Hawksworth and Wiens (1996) clearly indicate these species are sympatric. Although Nickrent et al. (2004) considered *A. campylopodum* and *A. siskiyouense* to be conspecific, this conclusion is based solely on molecular data and does not consider the morphological differences (plant color), phenology differences, or host susceptibility discontinuities between these populations. Further research is needed to clarify the host susceptibility of *P. ponderosa* to *A. siskiyouense* and *P. attenuata* to *A. campylopodum* discussed by Hawksworth et al. (1992) and Hawksworth and Wiens (1996). In addition, a detailed morphometric analysis of *A. campylopodum* is needed and this work should include analysis of the other mistletoes closely aligned with *A. campylopodum* in California: *A. occidentale* and *A. littorum*.

Arceuthobium monticola

Our morphological measurements of *Arceuthobium monticola* are summarized in Table 3. The plant dimensions we obtained for *A. monticola* were similar to those reported by Hawksworth et al. (1992), except that we measured plants that were larger (13 cm) than what they reported (10 cm). We also measured larger third internode and fruit dimensions than what they reported. The color of male and female plants of *A. monticola* was consistently dark brown, red-brown, or brown-green. Rarely male plants were brown-yellow to almost completely yellow, as are those of *A. californicum*. Our data include the first measurements of flower characteristics. Previous descriptions (Hawksworth et al. 1992) indicated that *A. monticola* only forms 3-merous flowers. However, we found that 3-merous flowers were usually more numerous on the same plant, but this character varied. The species produces both 3- and 4-merous flowers, and rarely 5-merous flowers, and we observed a few male plants that produced predominantly 4-merous flowers.

A comparison of morphological characters using our data for *Arceuthobium monticola* and those reported in Hawksworth and Wiens (1972, 1996) for *A. californicum* is presented in Table 4. Plant dimensions were approximately the same for both species, but plant color for *A. monticola* was usually dark brown or brown-green. However, some male plants were brown-yellow to yellow, as are those of *A. californicum*. Flowers and fruits of *A. monticola* were slightly larger on average than those of *A. californicum*, but seeds were smaller in length.

Although Hawksworth et al. (1992) and Hawksworth and Wiens (1996) reported that *Arceuthobium californicum* rarely parasitizes *Pinus monticola*, this is evidently based on one report of this mistletoe/host combination from Castle Lake Campground, west of Shasta City, CA (see Hawksworth and Wiens 1996, p. 334). Our field observations at Castle Lake, and our comparison of specimens of *A. californicum* and *A. cyanocarpum* (A. Nelson ex Rydb.) Coulter & Nelson, indicate the mistletoe infecting *P. monticola* at Castle Lake is *A. cyanocarpum*. Therefore, we consider there to be no confirmed reports of *A. californicum* on *P. monticola* at this time. We have observed *A. monticola* infecting *P. lambertiana* Dougl. at two locations in northern California, but this pine is clearly a rare host of *A. monticola* at both locations. In contrast, *P. lambertiana* is the principal host of *A. californicum*.

Anthesis of *A. monticola* begins in mid-July, peaks in early- to mid-August, and continues into early-September. Seed dispersal of *A. monticola* starts in early September, peaks in late September, and is finished by late October. While our observations of flowering for *A. monticola* agree with those reported by Hawksworth et al. (1992), our observations of seed dispersal indicate that peak seed dispersal for this species is in September, and not October to November. We consistently observed that *A. monticola* had completed seed dispersal by late October and did not extend this aspect of its life cycle into November as reported by Hawksworth et al. (1992).

Table 3. Morphological measurements for *Arceuthobium monticola* on *Pinus monticola*. Data are listed as mean (range) [n]. Letters in brackets indicate sample sizes already listed in the same column. Plant heights in cm and all other measurements in mm.

Character	A. monticola
Plant Height	
Male	7.8 (4.4–12.6) [50a]
Female	8.5 (6.1–13.4) [a]
Basal Diameter	
Male	2.8 (2.0–3.5) [a]
Female	2.9 (2.1–3.8) [a]
Length of Third Internode	
Male	9.9 (4.8–17.1) [a]
Female	11.5 (6.9–23.4) [a]
Width of Third Internode	
Male	1.7 (1.3–2.4) [a]
Female	1.7 (1.3–2.5) [a]
Staminate Spike Length	8.6 (5.0–14.2)[100b]
Staminate Spike Width	1.4 (1.1–1.8) [b]
Mean Flower Diameter	
3-merous	2.5 (2.0–3.1) [a]
4-merous	3.6 (3.0–4.6) [a]
Perianth Lobe Length	1.3 (0.8–1.7) [b]
Perianth Lobe Width	1.1 (0.7–1.3) [b]
Anther Diameter	0.5 (0.4–0.8) [b]
Anther Distance from Tip	0.6 (0.4–0.9) [b]
Mean Fruit Length	4.7 (4.0–5.6) [a]
Mean Fruit Width	3.0 (2.4–3.5) [a]
Seed Length	2.5 (1.8–3.2) [a]
Seed Width	1.2 (0.9–1.4) [a]

Our morphological data for *Arceuthobium monticola* further demonstrates its similarity to *A. californicum*, but these two species do have some morphological differences that can be used to distinguish them. While male and female plant sizes are similar and their ranges are nearly identical, the mean flower diameter of 3-merous flowers of *A. monticola* is smaller than that of *A. californicum*. In addition, the fruits of *A. monticola* are much larger and they are distinctly glaucous which causes them to appear blue, in contrast to the lightly-glaucous, green fruits of *A. californicum*. Plant color also distinguishes *A. monticola* (dark brown to brown-green) from *A. californicum* (yellow to green). Furthermore, *A. monticola* rarely parasitizes *Pinus lambertiana*, the principal host of *A. californicum* and thus far, *A. californicum* has not been confirmed to parasitize *P. monticola*, although this pine is common in the geographic range of *A. californicum* in the Sierra Nevada Mountains (Griffin & Critchfield 1972; Hawksworth and Wiens 1996). Although we have now collected *A. californicum* from the Klamath Mountains (near Etna and Orleans), its distribution still remains south of that for *A. monticola*, so thus far it does not appear that the geographic ranges of *A. monticola* and *A. californicum* overlap. Therefore, the classification of *Arceuthobium monticola* as a subspecies of *A. californicum* could be given consideration given the morphological, physiological, and molecular differences between them and their apparent geographic isolation (Nickrent & Butler 1991; Hawksworth et al. 1992; Nickrent et al. 2004). However, until we complete a detailed morphometric analysis with data for *A. californicum* from throughout its geographic distribution, we do not feel it would be appropriate to recombine *A. monticola* as a subspecies of *A. californicum* here.

Although the dimensions and color of male and female plants of *A. siskiyouense* and *A. monticola* were

TABLE 4. A comparison of morphological characters for *Arceuthobium monticola* and *A. californicum*. Data is listed as mean (range). Data for *A. californicum* is from Hawksworth et al. 1992 (Table 2) and Hawksworth and Wiens (1996, page 197). Single numbers in columns are means as no range information was available for *A. californicum*. Plant heights in cm and all other measurements in mm.

Character	A. monticola	A. californicum
Plant Height [a]	8.2 (4.4–13.4)	8.0 (6.0–14.0)
Basal Diameter [a]	2.8 (2.0–3.8)	2.0 (1.5–4.0)
Length of Third Internode [a]	10.7 (4.8–23.4)	10.5 (5.0–16.0)
Width of Third Internode [a]	1.7 (1.3–2.5)	1.5 (1.0–2.0)
Plant Color [a]	Dark brown, red-brown, brown-green or rarely yellow-brown or yellow	Yellow to greenish
Mean Flower Diameter [b]	2.5	3.3
Perianth Lobe Length	1.3	1.5
Perianth Lobe Width	1.1	1.1
Anther Diameter	0.5	0.5
Anther Distance from Tip	0.6	0.7
Mean Fruit Length	4.7	4.0
Mean Fruit Width	3.0	2.5
Fruit Color	Blue (highly glaucous)	Green (slightly glaucous)
Seed Length	2.5	3.2
Seed Width	1.2	1.2

[a] – Male and female plants combined.
[b] – 3-merous flowers.

also similar based on our findings, they differed in their flower characteristics for both 3- and 4-merous flowers, and fruit and seed sizes (compare Tables 1 and 3). In addition, *Pinus attenuata* is considered to be immune to infection by *A. monticola* (Hawksworth and Wiens 1996), a conclusion our field observations in several severely *A. monticola*-infested mixed stands of *Pinus monticola* and *P. attenuata* supports. Our field observations and those of Hawksworth and Wiens (1996) also indicate that *P. monticola* is immune to infection by *A. siskiyouense*. Furthermore, Nickrent and Butler (1991) found that these species were genetically different based on their electrophoretic analysis of isozymes.

A comparison of the descriptions of *Arceuthobium campylopodum* in Hawksworth and Wiens (1972, 1996) with our morphological and physiological data for *A. sikiyouense* and *A. monticola* could be interpreted as support for the classification of these species as conspecific with *A. campylpodum* as suggested by Nickrent et al. (2004), but could also support their recombination as subspecies of *A. campylopodum*. Whether or not these *Arceuthobium* taxa deserve taxonomic recognition as distinct species, subspecies, or are conspecific with *A. campylopodum* will continue to be debated by plant systematists, as well as forest managers and wildlife biologists whose interests in *Arceuthobium* spp. have economic and ecological implications (Hawksworth & Wiens 1996; Nickrent et al. 2004; Mathiasen et al. 2008). Clearly, further research is warranted on the morphological, physiological, and molecular relationships of the species discussed here as well as all the taxa included in Section *Campylopoda* by Hawksworth and Wiens (1996).

ACKNOWLEDGMENTS

The assistance of M. Socorro González Elizondo with an early review of the manuscript and the Spanish translation for the Spanish resumen is greatly appreciated. Robert Scharpf kindly reviewed the paper as well.

REFERENCES

GRIFFIN, J.R. AND W.B. CRITCHFIELD. 1972. The distribution of forest trees in California. Research Paper PSW-82, USDA Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley, CA.

CRITCHFIELD, W.B. 1980. Genetics of lodgepole pine. Research Paper WO-37. USDA Forest Service, Washington, DC.

HAWKSWORTH, F.G. AND D. WIENS. 1972. Biology and classification of dwarf mistletoes (*Arceuthobium*). Agriculture Handbook 401, USDA Forest Service, Washington, DC.

HAWKSWORTH, F.G. AND D. WIENS. 1996. Dwarf mistletoes: biology, pathology, and systematics. Agriculture Handbook 709, USDA Forest Service, Washington, DC.

HAWKSWORTH, F.G., D. WIENS, AND D.L. NICKRENT. 1992. New western North American taxa of *Arceuthobium* (Viscaceae). Novon 2:204–211.

HICKMAN, J.C. (ed.). 1993. The Jepson manual: higher plants of California. University of California Press, Berkeley.

MATHIASEN, R.L. AND C.M. DAUGHERTY. 2009. Comparative susceptibility of conifers to knobcone pine dwarf mistletoe. W. N. Amer. Naturalist 69:42–48.

MATHIASEN, R.L., D.L. NICKRENT, D.C. SHAW, AND D.M. WATSON. 2008. Mistletoes: pathology, systematics, ecology, and management. Pl. Dis. 92:988–1006.

NICKRENT, D.L. AND T.L. BUTLER. 1990. Allozyme relationships of *Arceuthobium campylopodum* and allies in California. Biochem. Syst. Ecol. 18:253–265.

NICKRENT, D.L. AND T.L. BUTLER. 1991. Genetic relationships in *Arceuthobium monticola* and *A. siskiyouense* (Viscaceae): New dwarf mistletoe species from California and Oregon. Biochem. Syst. Ecol. 19:305–313.

NICKRENT, D.L., M.A. GARCÍA, M.P. MARTÍN, AND R.L. MATHIASEN. 2004. A phylogeny of all species of *Arceuthobium* (Viscaceae) using nuclear and chloroplast DNA sequences. Amer. J. Bot. 91:125–138.

BOOK REVIEW

Gina Donovan, with Stephen D. Lange and Adrian F. Van Dellen. 2009. **Neches River User Guide.** (ISBN 978-1603441384, pbk.). Texas A&M University Press, John H. Lindsey Building, 4354 TAMU, College Station, Texas 77843-4354, U.S.A. (**Orders:** www.tamu.edu/upress, 1-800-826-8911). $17.95, 83 pp., 72 color photos, 40 color maps, 5 b&w photos, 18 tables, 5 1/2" × 8 1/2".

The Neches River follows a leisurely course through a large portion of Texas' scarce public lands, both current and future, and privately owned land. The *Neches River User Guide* is a project of the Texas Conservation Alliance and educates readers as to the myriad ways this river can be enjoyed. The guide follows the river south from Lake Palestine Dam to the Downtown Dock & Lawn in Beaumont.

Printed in portrait format, the guide is meant to be used spine up, principally to facilitate use of the maps section, thus users can flip through it and easily view the maps, illustrations, and a GPS coordinates chart. Each segment has two maps that "reveal the towns, roads, entry points, bridges, public lands, parks, and other landmarks along nearly 360 miles of the river's course." One map offers a quick overview of the segment of the river covered and shows its relationship to local communities and points of interest. The larger and more detailed map shows "practical information about public access points, potential hazards, camping facilities, and GPS coordinates for points of interest" along the river.

Also included is a "brief description of the archeology and history of human habitation along the river, as well as photographs of plants and animals common in the bottomland hardwood ecosystem." Descriptions of conservation efforts seek to invoke in readers a feeling of stewardship for the river so that it may be enjoyed by all for years to come.

Printed on waterproof paper, the *Neches River User Guide* is a handy, pocket-sized, and sturdy map guide for everyone who wants to experience the Neches River first-hand—campers, paddlers, birders, hikers, hunters, and outdoor enthusiasts in general. Recommended for all public libraries and collections that have an interest in riverine studies, ecology, and leisure activities in Texas.

Gina Donovan is executive director of the Houston Audubon Society. Co-founder of the East Texas Forest & Wildlife Coalition, she also served on the Texas Parks and Wildlife Department's Rivers Conservation Advisory Board. Stephen D. Lange is a Regional GIS Specialist for the Texas Parks & Wildlife Department's Wildlife Division in Tyler, Texas. Adrian F. Van Dellen, DVM, is a retired United States Air Force pathologist and an avid canoer and nature photographer.—*Gary Jennings, Librarian, Botanical Research Institute of Texas, Fort Worth, Texas 76102-4025, U.S.A.*

J. Bot. Res. Inst. Texas 3(2): 750. 2009

ADDITIONAL OBSERVATIONS ABOUT *PHASEOLUS ROTUNDATUS* (FABACEAE), AN ENDEMIC BEAN SPECIES FROM WESTERN MEXICO

Jesús Salcedo C.
Bioversity International
Office for the Americas
c/o CIAT, COLOMBIA
j.m.salcedo@cgiar.org

Rogelio Lépiz I.
University of Guadalajara
Centro Universitario de Ciencias
Biológicas y Agropecuarias
Jalisco, MÉXICO
rlepiz@cucba.udg.mx

Nora Castañeda A.
Bioversity International
Office for the Americas
c/o CIAT, COLOMBIA

César Ocampo N. and Daniel G. Debouck
International Center for Tropical Agriculture (CIAT)
AA 6713
Cali, COLOMBIA
d.debouck@cgiar.org

ABSTRACT

Further information is presented about *Phaseolus rotundatus*, a new bean species for western Mexico, where it appears to be endemic and endangered, with very few populations reported to date, and all outside current protected areas. The differences between *P. rotundatus* and *P. marechalii* (both of *Phaseolus* section *Paniculati* Freytag), the closest taxon with which it can be confused, are highlighted to confirm the validity of the former taxon.

RESUMEN

Se presentan resultados que confirman la validez de *Phaseolus rotundatus*, como especie endémica y en peligro de extinción en el occidente de México, con muy pocas poblaciones conocidas a la fecha y ubicadas en su mayoría fuera de áreas protegidas. Se consignan las diferencias principales con *P. marechalii* (ambas de la sección *Paniculati* Freytag del género *Phaseolus*), especie cercana con la cual podría confundirse, para confirmar la validez de *P. rotundatus*.

INTRODUCTION

A new wild bean species, *Phaseolus rotundatus* Freytag & Debouck, was described for western Mexico (Freytag & Debouck 2002). It is a tall woody climbing vine with rounded rhombic, densely pubescent, trifoliolate leaves and stout panicles with lilac-purple flowers. The double racemic structure of its inflorescences with development of the secondary raceme axis (Debouck 1983) clearly places it in the section *Paniculati* Freytag of the genus. The species was first collected by Rogelio Lépiz in October 1978, and shown later in that year as a herbarium voucher to the senior author (DGD), who could not identify it, but confirmed it as a '*Phaseolus sensu stricto*' as the genus was understood by then (Maréchal et al. 1978). Although the voucher was slightly overburnt during drying, Robert Maréchal was able to obtain a living specimen in the glass-house in Gembloux, Belgium (as NI 1046, also G40693 at CIAT). George F. Freytag obtained later seed of that plant, and on the indication by the senior author (DGD) aptly described *P. rotundatus* as grown in a growth chamber at the Tropical Agriculture Research Station of USDA, Mayagüez, Puerto Rico (Freytag & Debouck 2002). Conditions were not ideal for the preparation of type specimens (currently the holotype is US3386751, and isotypes are kept at CS, F, and MICH, none with complete reproductive parts). Additional material was collected in the field by R. Lépiz and D. Debouck in recent years. These latest collections enabled additional observations on blastogeny and palynology, which are reported below. Because of a possible confusion with a closely related species, viz *Phaseolus marechalii* Delgado (Delgado 2000), attention is drawn to differences between these two taxa.

J. Bot. Res. Inst. Texas 3(2): 751 – 762. 2009

RESULTS

Morphological observations

The following complements the description given elsewhere (Freytag & Debouck 2002) on plants grown for several years in CIAT Palmira, Colombia, and seen in Río Verde, Jalisco, Mexico in November 2003. The small amount of variation observed for many morphological traits between plants grown artificially in Mayagüez (18°12'28" lat N, 67°08'18" long W !) and in the field in Palmira (3°30'06" lat N, 76°21'21"long W) is noteworthy.

Seedling 15–18 cm high, from hypogeal germination; epicotyl green, terete, 80–100 mm long, covered with white uncinate trichomes (Fig.1a, 2e left). Eophylls simple, deltoid, green (146B Yellow – green group; Anonymous 1966), opposite, with minute white uncinate trichomes on adaxial and abaxial surfaces, 30 × 25 mm, apex acute to acuminate, base slightly cordate; petioles green, 15 mm long, minute stipels, pulvini dark green, pubescent; stipules triangular, basifixed, 1–2 mm long, highly pubescent, 3- nerved, green. First true leaf trifoliolate, leaflets ovate to elliptic. **Root** diameter 8–12 cm or more, 50 cm long or more, pluriannual thick fleshy and woody, with 3–6 conical subdivisions 15–30 cm long of 1–4 cm diameter, with prominent whitish nodules and dark brown corky cortex. **Stems** terete stout erect in lower parts and climbing in upper parts, woody and enlarged at base, total length 2–4–8 m (Fig. 2b), diameter 2–5–8 mm, internodes 12–14 cm green (144A) densely covered with white short strigose pubescence. **Stipules** triangular acute 4 mm long 2 mm wide covered by whitish pubescence. **Leaves** trifoliolate 13–18 cm long, terminal leaflets rhombic rounded to orbicular (57 × 55 mm to 67 × 62 mm) greenish (147A) because of whitish dense pubescence, lateral leaflets similar but slightly inequilateral (53 × 45 mm to 65 × 64 mm); petioles 3–6–10 cm long, petiolules 9–20–30 mm long; lower pulvini 4–6 mm long, upper pulvini 2–3 mm long; stipels ligulate 2–3 mm long. **Inflorescence** a panicle with 20–30 or more secondary racemes, some of them developed at base, 35–75 cm long (Fig. 2a); the peduncle 12–22 cm long stout slightly curved and reddish at base densely covered with white short strigose pubescence and minute uncinate hairs; the rachis 18–51 cm long usually erect green with 15–20–30 secondary racemes irregularly spaced, often with development of axis beyond second flower, subtended by triangular aciculate primary bracts 2.5–3 × 1.2 mm strongly 3-nerved covered by whitish pubescence. Pedicels terete straight or slightly recurved 4–6 mm long covered with white short strigose pubescence and minute uncinate hairs. Pedicelar bracts linear 1 mm long 1-nerved densely covered by whitish pubescence. **Bracteoles** green triangular narrow hirsute 1mm long or less strongly 1-nerved densely covered by whitish pubescence (Fig. 1e). **Flowers** papilionaceous (Fig. 1c, 1d, 2d left) purple pink (72B red-purple) fading violet blue (85A violet), two for each secondary raceme (Fig. 1b); calyx round cupped green turning to tan at insertion of pedicel, hirsute, margin shortly ciliate, tube 3.5 mm long, two upper calyx lobes fused unconspicuous, three lower lobes triangular apiculate 1 × 1 mm long (Fig. 1e); standard outer face pale lilac glabrous with a few straight short hairs on top, inner face purple pink intense with auricles 4–5 veined, squarish with a deep central sinus, 11 × 8.5 mm, thickened at flexure, auricles rounded slightly reflexed, the right auricle more developed, claw green reddish 1.5 mm long with two parallel rounded green pinkish callosities (Fig. 1f); wings spreading horizontally, intense purple pink, obovate rounded subequal, the margins often revolute particularly on the left wing, the blade 8 × 6 mm glabrous, the squarish spur slightly adhering to the keel, claw linear 4 mm long (Fig. 1g); keel tubular in close asymmetrical spiral spreading to the left white greenish at base, pink purple in the ascending part, greenish at top, 1 ¾ counterclockwise closed coils, ca 12 mm long, two claws divided 2 mm long whitish with a few pink spots, a convex rounded pocket 1 mm long above each claw (Fig. 1h); stamens diadelphous (9+1): vexillary stamen free 11 mm long claw terete 2 mm long to cupped knob 1 mm diameter (Fig. 1j); staminal tube 11 mm long slightly veined with two small rounded callosities flanking the knob (Fig. 1i); anthers yellow dithecal oval dorsifixed. Ovary green glabrous 5 × 1 mm laterally compressed margins slightly pronounced inserted on a smooth basal disk 1 mm diameter, 4 ovules; style spiraled ca 11 mm long terete glabrous, a brush of straight 1 mm long hairs unilaterally extending below the stigma not beyond, stigma narrowly triangular white 1 mm long not extending beyond style tip (Fig. 1k). **Pods** falcate small 28–45

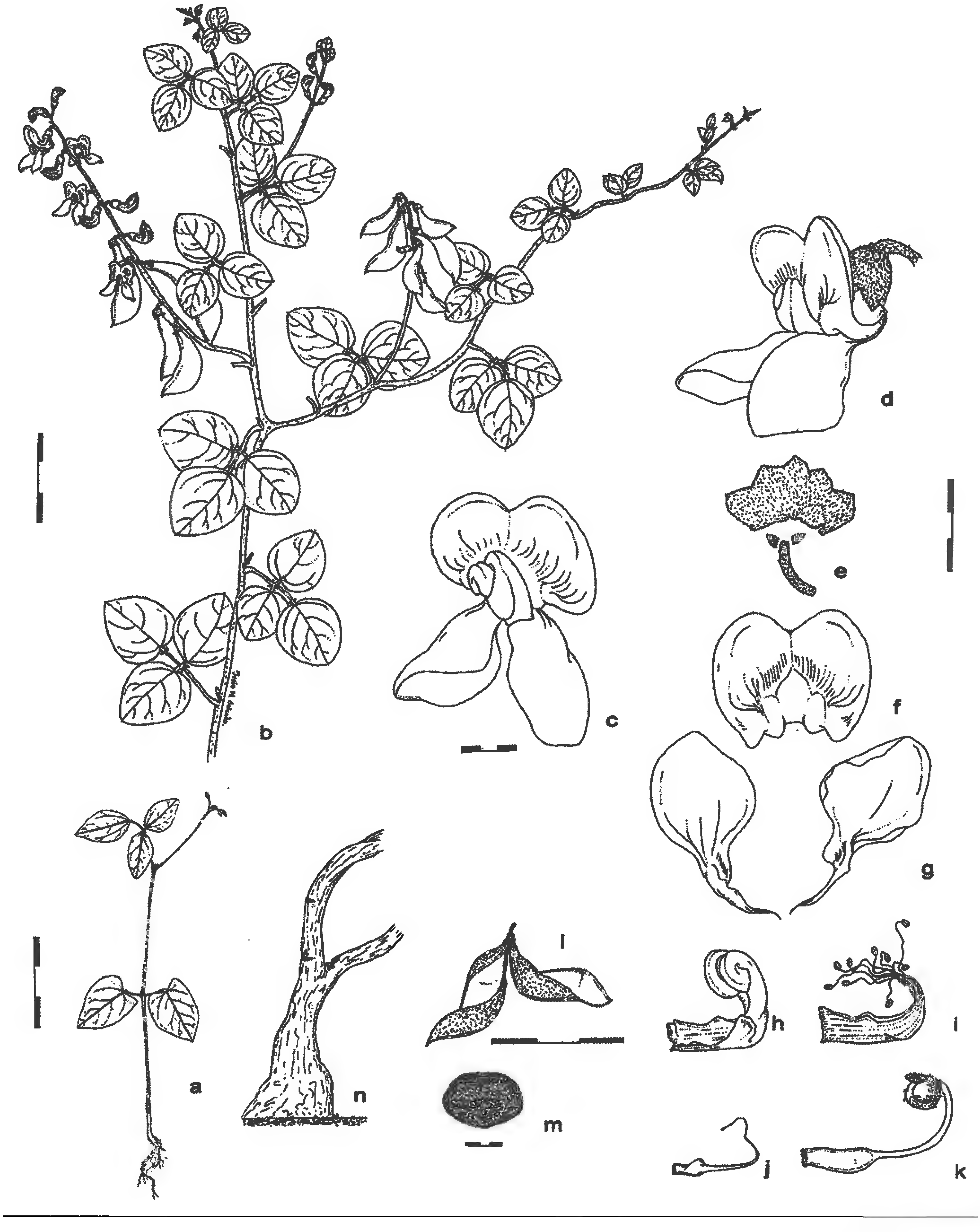


Fig. 1. *Phaseolus rotundatus* Freytag & Debouck. **a.** Seedling. **b.** Habit of young fertile stem. **c.** Flower (front view). **d.** Flower (lateral view). Floral parts (eh): **e.** Pedicel, bracteoles and calyx. **f.** Standard. **g.** Wings. **h.** Keel. **i.** Staminal tube. **j.** Vexillary stamen. **k.** Ovary and style. **l.** Pod. **m.** Seed.. **n.** Root system and lower part of oneyear plant. Scale: a–b, l, n in cm; d–m in mm. All drawings made from plants grown in Palmira, Colombia, of seed from the type collection (*Lépiz s.n.*) from near Río Verde, Tepatitlán, Jalisco, Mexico.

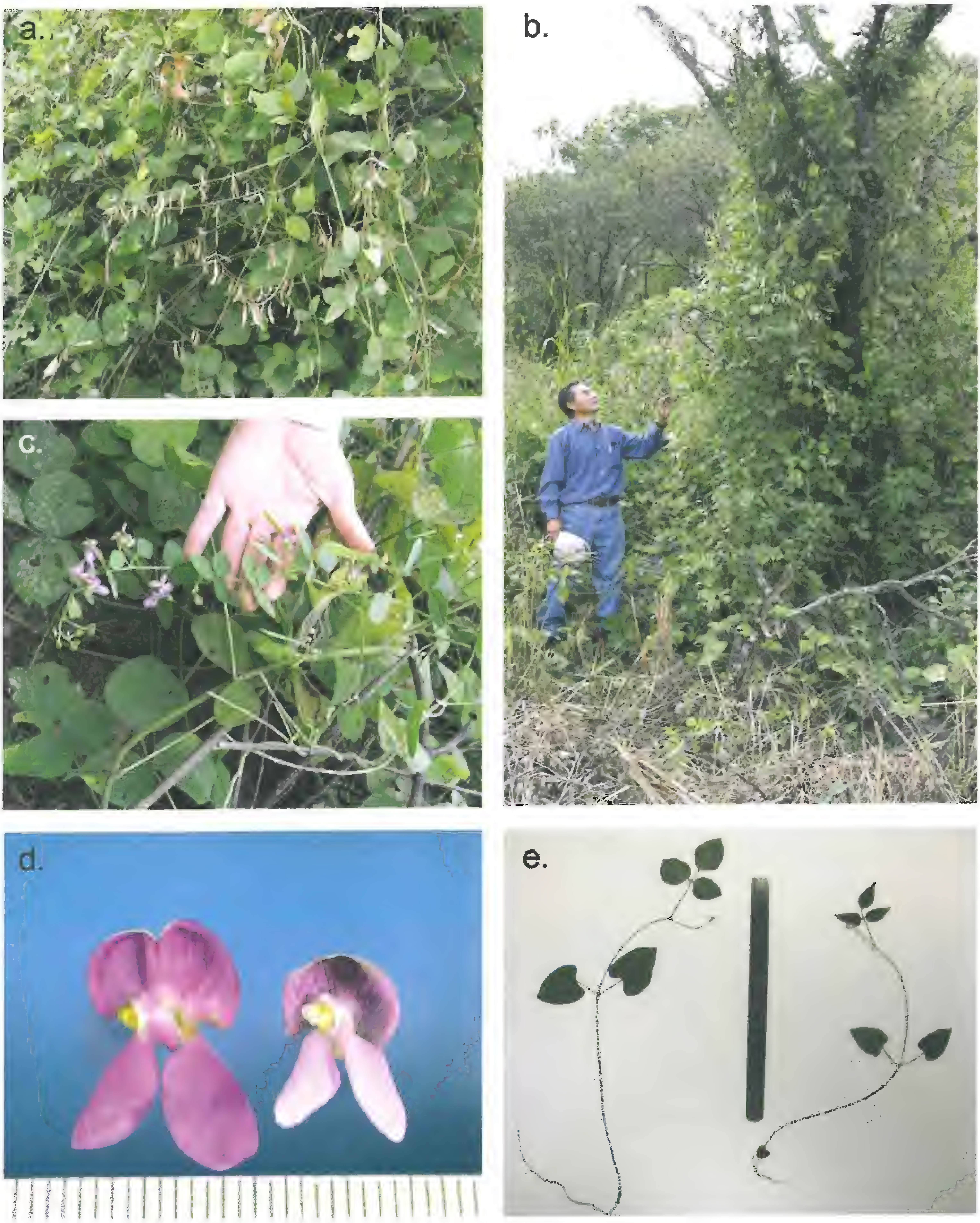


Fig. 2. a, c. Fruiting parts of *P. rotundatus*, fully mature and young, respectively. **b.** Fully developed plant at the type locality. **d.** Flowers of *P. rotundatus* (left) and *P. marechalii* (right; same materials as in Fig. 3a and 3b; each grade below is one mm). 2e. seedlings of *P. rotundatus* (left; G40693) and of *P. marechalii* (right; G40506). Steel rule at center: total length 15 cm.

mm long, 8–10 mm wide, 2–4 seeded, flattened, slightly constricted between the seeds; valves glaucous green (144B) drying tan (164B), twisting 1 ½ at dehiscence, the sutures finely thickened, the beak curved downwards 1–2 mm long. **Seed** round ovale oblong 6–8 mm long 5 mm wide 2–3 mm thick (Fig. 3a), 100-seed weight 7–9 g, cream tan background covered by a dense fine black speckle with a black ring around the hilum; hilum irregularly elliptic 1.2 mm long 0.6 mm wide; lens small and slightly raised. **Pollen** (Fig. 4a and 4d) round (polar view), subprolate, tricolporate with 6 pseudocolpi, medium-sized, diameter 25–27 μm, almost spherical; margins surrounding the colpi prominent and smooth 3 μm wide; endoaperture elliptic (longer axis 7 μm); endoaperture membrane smooth, ectoaperture membrane finely punctate; tectum finely punctuate.

Specimens examined: For *P. rotundatus*: [State of] **Jalisco:** [County of] Tepatitlán de Morelos: Río Verde, [Lat. 21°00'07"N. Long. 102°48' 10"W]. 1,200 m, 22 Oct 1978, *R Lépiz s.n.* (additional specimens from the type grown and bred true at CIAT Palmira station, and hereby distributed to BRIT, COL, CS, F, FHO, FI, GH, K, IBUG, IEB, MEXU, MICH, NA, NY, SI, TEX, UC; in addition, small amounts of seeds, accessioned as G40693, can be obtained from the Genetic Resources Program of CIAT).

For *P. marechalii*: **México:** Villa del Carbón, 12 km SE de Villa del Carbón, 19°41'N, 99°25'W, 2520 m, 6 Nov 1987, *DG Debouck & JS Muruaga Martínez 2377* (MICH1179985; US3168490). **Morelos:** Sierra Morelos, Cuernavaca, [19°01'N. 99°15'W], 2000 m, 7 Nov 1969, *Hinton 17462* (K; collected by James Hinton !?); Tepoztlán, 18°59'N, 99°06'W, 1900 m, *Leroi Mex-130* (COL, GH, K, IBUG); in pedregal barranca just below 62 Km marker, which is about 14 km north of Cuernavaca, [19°04'N. 99°15'W], 27 Oct 1947, *OW Norvell HM 215* (UC933928; isotype of *P. glaucocarpus* Norvell sp. nov. ined.); "No d'introduction 402. Faculté des Sciences Agronomiques de l'Etat Gembloux, Chaire de Phytotechnie des Régions Chaudes. Herbier no. 2386. *Phaseolus* sp. Provenance: gr[aines] reçues de M^r *Schubert*, Morelos 623, Mexique. [19°02'N. 99°17'W]. Rec: 10/2/1971 serre Gembloux" (K). **Puebla:** Acajete, cerro 4 km NE de Pueblo Acajete, 19°08'N, 97°54'W, 2400 m, 11 Nov 1987, *DG Debouck & JS Muruaga Martínez 2389* (BR; MICH1179986; US3168489).

On the basis of the revision of herbarium specimens mentioned above and the observation of plants grown out side-by-side in the experimental station of CIAT in Palmira, we summarize the main differences between *P. rotundatus* and *P. marechalii* in Table 1.

Ecology

From the two populations known so far (at Río Verde, with a difference in altitude of 200 m), *P. rotundatus* seems distributed in oak grasslands around the upper reaches of the valley of Río Grande de Santiago, while *P. marechalii* thrives in pine-oak forests of the Trans-Mexican Volcanic Belt (Fig. 6).

Electrophoretic evidence and species relationships

A quick survey of seed storage proteins in one-dimension SDS-PAGE electrophoresis, using 15% polyacrylamide slab gels as in Brown et al. (1981) modified by Gepts et al. (1986) (Fig. 5), indicates very similar patterns of banding for *P. rotundatus* (lane 3), *P. marechalii* (lane 4) and *P. jaliscanus* Piper (lane 5). *P. novoleonensis* Debouck (lane 6) of the *Coriacei* section (Salcedo et al. 2006) is then close, although with much less in globulins around 50–52 kD. *P. lunatus* L. (wild Mesoamerican form - lane 2) and *P. glabellus* Piper (lane 7) show almost no globulins in the range of 50–52 kD, but have significant amounts of storage proteins around 35 kD. The section *Phaseoli* is represented by *P. costaricensis* Freytag & Debouck (lane 9) and *P. vulgaris* L. (wild Mesoamerican - lane 10) with a significant amount of phaseolin (50–52 kD), a possible arcelin in wild *P. vulgaris* (35 kD) and a possible lectin-like protein in *P. costaricensis* (24–25 kD). *P. chiapasanus* Piper (lane 8) would have a significant amount of globulin too (50 kD).

DISCUSSION

The data above were collated to show the differences between *P. rotundatus* and *P. marechalii* and are additional to the ones reported elsewhere (Freytag & Debouck 2002). They elicit the following points for discussion. First, *P. rotundatus* is a taller, aggressively climbing vine as compared to *P. marechalii*; plants topping trees 5–6 m high (Fig. 2b) are frequent, thus with stems up to 8–10 m long. Racemes and flowers are larger as compared to those of *P. marechalii* (Fig. 2a, c, and d). Other differences exist in seedlings (Fig. 2e), seeds (Fig. 3a and 3b), and pollen (Fig. 4a,d and 4b,c). Terminal leaflets of fully developed leaves are 67 × 62 mm in *P. rotundatus*, while 50 × 32 mm in *P. marechalii*.

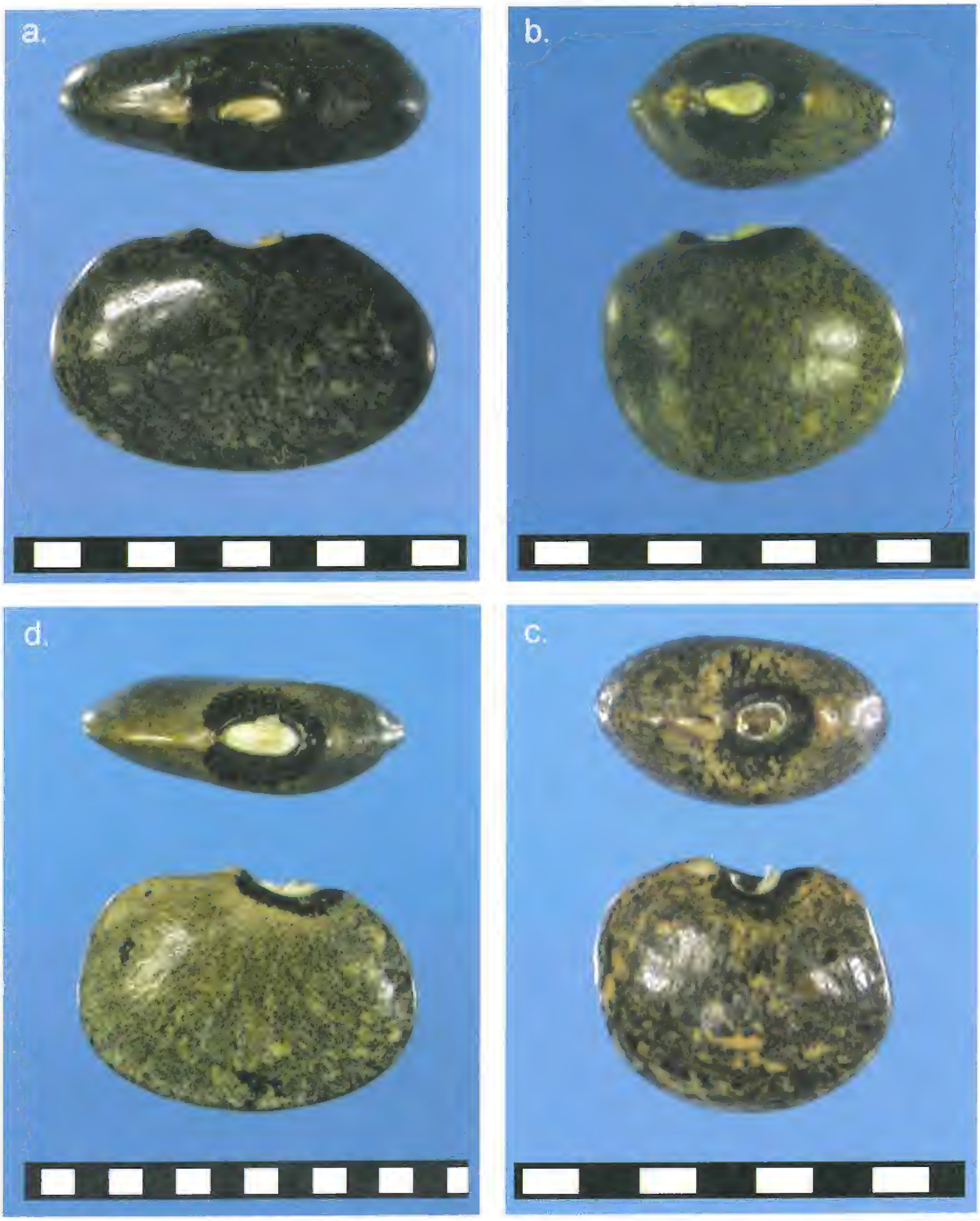


Fig. 3. Close-ups of seeds in lateral views and views from hilum (clockwise) of: **a.** *P. rotundatus* (*Lépiz s.n.*; G40693) from type collection site. **b.** *P. marechalii* (*Bernice Schubert 623*; G40506; NI 402) from surroundings of Huitzilac, Morelos, Mexico. **c.** *P. polystachyus* (*M Bassett s.n.*; G40783) from surroundings of Gainesville, Alachua County, Florida, USA. **d.** *P. lunatus* (*DGD-527*; G25741) from Chunhuas, Hecelchakan, Campeche, Mexico. The scale bar is one mm for each division, and may change slightly from one shooting to another.

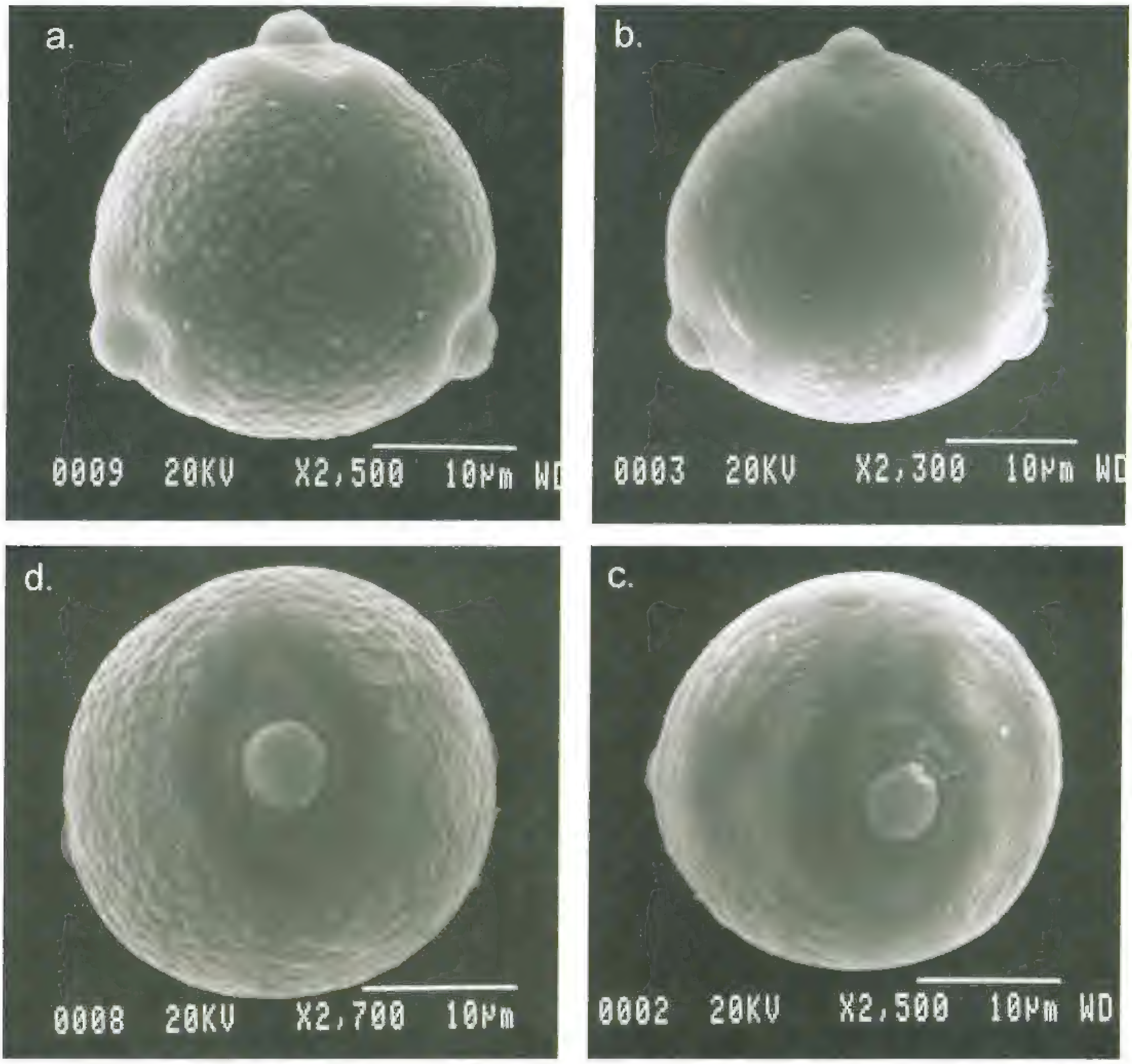


Fig. 4. Pollen types of *P. rotundatus* (left, 4a and 4d) and *P. marechalii* (right, 4b and 4c). Polar (4a, 4b) and equatorial (4c, 4d) views. Scale bar: 10 microns.

Table 1. Summary of the main differences between *P. rotundatus* and *P. marechalii*.

Trait	P. rotundatus	P. marechalii
Seedling	Larger eophylls (30 x 25 mm); leaflets of 1st true leaf bluntly acuminate	Smaller eophylls (22 x 15 mm); leaflets of 1st true leaf acuminate
Plant	Stout and robust climbing vine, usually more than 4 m high	Stout climbing vine, usually less than 3 m high
Leaves	Large 13–18 cm long, leaflets rhombic rounded	Small 7–11 cm long, leaflets ovate acuminate
Racemes	Large panicles, more than 20 cm long	Small panicles, less than 20 cm long
Inner standard	Veining diffuse	Clearly vertically veined
Seed	Ovale flattened	Round ovoid thicker
Habitat	Oak savannahs of N-NE Jalisco, Mexico	Pine-oak forests of Trans-Mexican Volcanic Belt, central Mexico

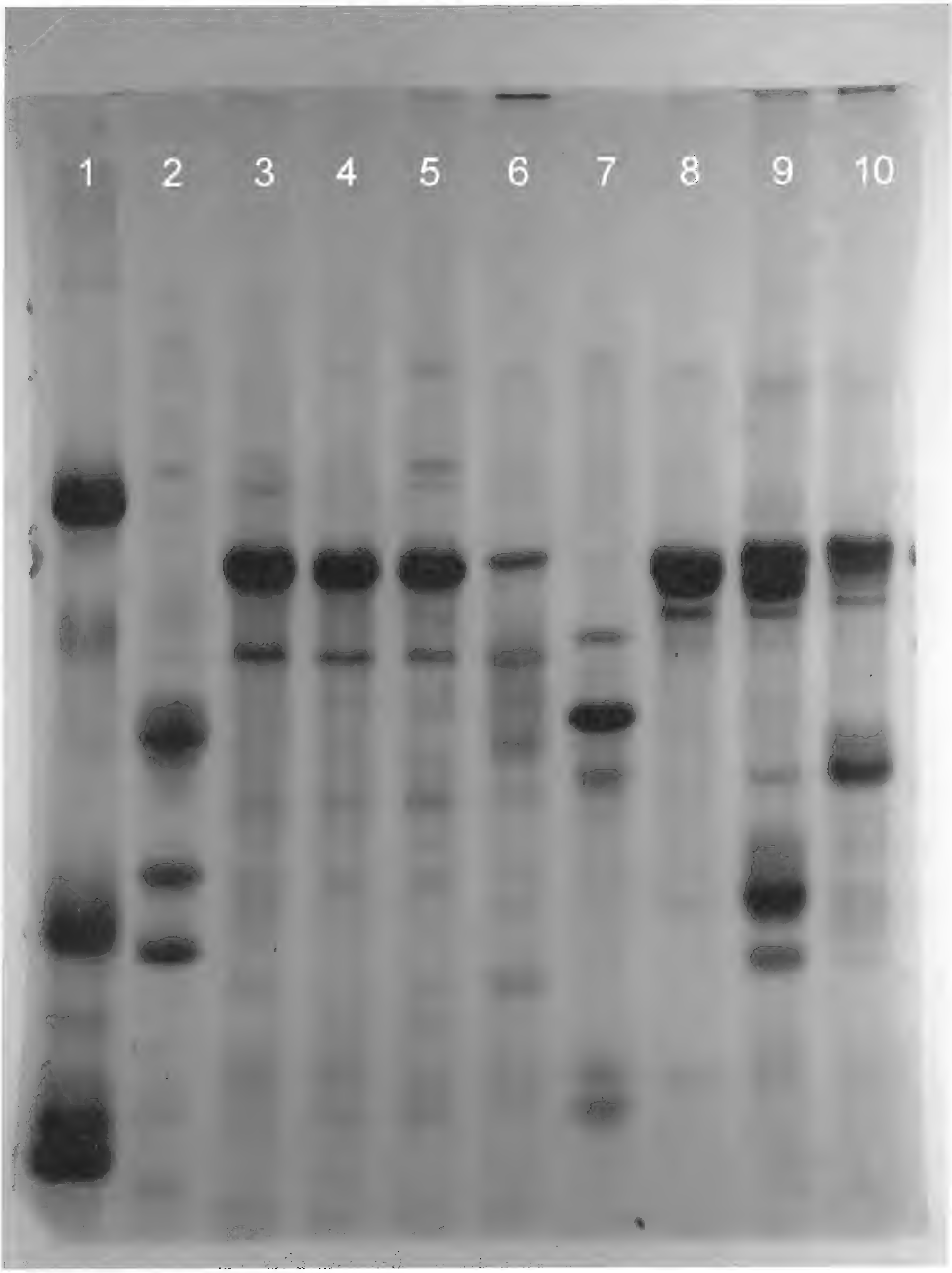


Fig. 5. One dimensional SDS-PAGE gel of *Phaseolus rotundatus* and selected taxa. **Lane 1:** molecular weights in kiloDaltons (range 14.3 lower band to 66 upper band). **Lane 2:** *P. lunatus* wild (*DGD-453* from Jalisco, Mexico; G25704). **Lane 3:** *P. rotundatus* (*Lépiz s.n.* from Jalisco, Mexico; G40728). **Lane 4:** *P. marechalii* (*B Schubert 623*; G40506). **Lane 5:** *P. jaliscanus* (*R Buhrow M21* from Jalisco, Mexico; PI 535313). **Lane 6:** *P. novoleonensis* (*DGD-2061* from Nuevo León, Mexico; G40590). **Lane 7:** *P. glabellus* (*DGD-2043* from San Luís Potosí, Mexico; G40585). **Lane 8:** *P. chiapasanus* (*J Muruaga Martínez 4005* from Oaxaca, Mexico; G40676). **Lane 9:** *P. costaricensis* (*DGD-2119* from Cartago, Costa Rica; G40604). **Lane 10:** *P. vulgaris* wild (*HSG-22202* from Jalisco, Mexico; G12866).

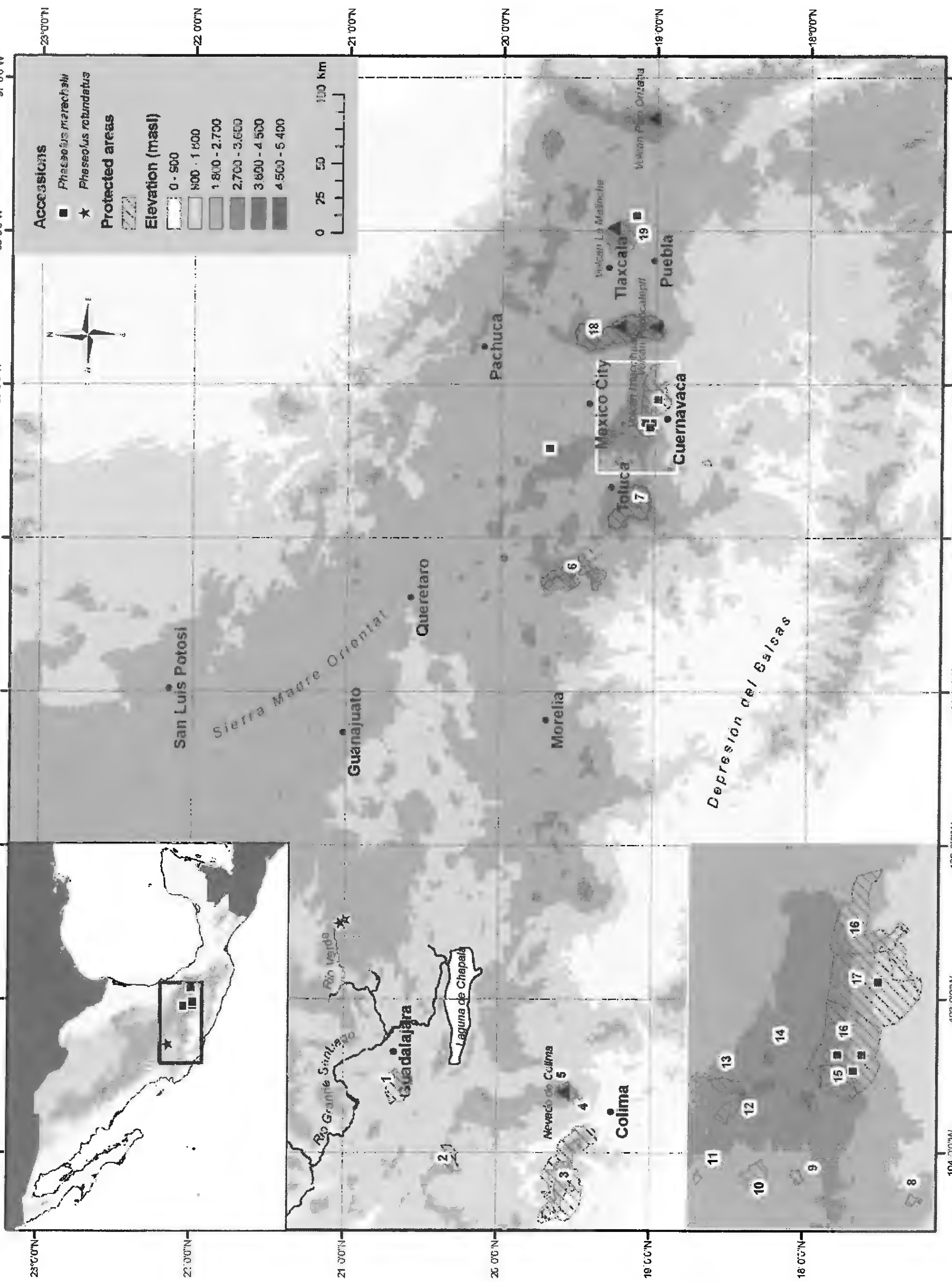

Accessions
Phaseolus marechalii
Phaseolus rotundatus
Protected areas
Elevation (masl)
0 - 900
900 - 1,800
1,800 - 2,700
2,700 - 3,600
3,600 - 4,500
4,500 - 5,400
0 25 50 100 km
San Luis Potosí
Sierra Madre Oriental
Querétaro
Guanajuato
Pachuca
Tlaxcala
Puebla
Mexico City
Toluca
Cuernavaca
Morelia
Depresión del Balsas
Guadalajara
Laguna de Chapala
Río Grande Santiago
Río Verde
Nevado de Colima
Colima
Volcán La Malinche
Volcán Pico Orizaba
23°0'0"N
22°0'0"N
21°0'0"N
20°0'0"N
19°0'0"N
18°0'0"N
97°0'0"W
98°0'0"W
99°0'0"W
100°0'0"W
101°0'0"W
102°0'0"W
103°0'0"W
104°0'0"W

Fig. 6. Distribution map of populations of *Phaseolus rotundatus* (stars white outlined) and *P. marechalii* (solid squares white outlined) in western and central Mexico. 1 = Wildlife refuge "La Primavera"; 2 = Wildlife refuge "Sierra de Quila"; 3 = Biosphere reserve "Sierra de Manantlán"; 4 = Wildlife refuge "El Jabalí"; 5 = National park "Nevado de Colima"; 6 = Biosphere reserve "Mariposa Monarca"; 7 = National park "Nevado de Toluca"; 8 = National park "Desierto del Carmen"; 9, 10, 11 = Wildlife refuge "Cienagas de Lerma"; 12 = National park "Insurgente Manuel Hidalgo y Costilla"; 13 = National park "Desierto de Los Leones"; 14 = National park "Cumbres del Ajusco"; 15 = National park "Lagunas de Zempoala"; 16 = Wildlife refuge "Chichinautzin"; 17 = National park "El Tepozteco"; 18 = National park "Iztaccihuatl-Popocatepetl"; 19 = National park "La Malinche".

Second, *P. rotundatus* seems to be known from only one locality to date, distributed on the upper slopes of the high valley of Río Grande de Santiago and possibly surrounding mountains or volcanoes. Study of over fifty herbaria holding specimens of the section *Paniculati* (Debouck 2009) has not revealed additional populations. Delgado (2000) reported a distribution around the Mexican state of Morelos for *P. marechalii*; from the novel records it is still a rare species as he indicated, restricted to the Trans-Mexican Volcanic Belt. Both species were not reported in "Flora Novo-Galiciana" (McVaugh 1987), perhaps another indication of their scarcity in and around Jalisco. A hypothesis worth further testing is that *P. rotundatus* had a wider distribution in the past than at present, namely in the valley of Guadalajara, before encroachment by agriculture and urbanization. The putative reduction in its distribution could be attributed to its plant type: it is a perennial vine reaching considerable development, and unlikely to survive under intense grazing pressure, plowing and fire, all characteristic of post-Columbian land use practices in central Jalisco. Today it only survives where humans, cattle and goats have no access, although places with little deep soil like cliffs are not its primary habitat.

Currently, as it can be judged from few sources (Toledo & Ordoñez 1993; Castilleja et al. 1996; Toledo et al. 1997), few populations of *P. marechalii* and none of *P. rotundatus* are included in protected areas. However, it would still be timely to include some populations of these two species into protection schemes, by slightly expanding current protected areas (for example, to the east the National Park 'La Malinche', or to the north west the National Park 'El Tepozteco'), or creating an area S of Río Verde bridge for *P. rotundatus* (where the slopes of road sides of federal road Mex 25 are a wasteland anyway). An additional justification for further *in situ* conservation efforts stems from the fact that the upper Santiago watershed might be involved in the domestication of common bean (Chacón et al. 2005; Kwak et al. 2009), because of the presence of wild forms (our germplasm collections of 1978; Zizumbo et al. 2009).

On the other hand, the unicate specimen collected by Howard Scott Gentry (*HS Gentry 22509*) in Telixtlahuaca, Oaxaca, Mexico, and kept at the US National Arboretum (NA0027957) has been identified by GF Freytag on July 26, 1989, as *Phaseolus subrotundatus* Freytag & Debouck (ined.). We have seen this specimen on July 18, 2006, and can discard this identification because this specimen has two short racemes (12 and 9 cm) with 5–6 primary bracts and the leaflets are almost glabrous. This means that there would be no disjunct distribution for *P. rotundatus* between Jalisco and Oaxaca, of limited distribution in the upper valley of Río Grande de Santiago in Jalisco, and that *HS Gentry 22509* belongs to another taxon.

Third, on the basis of electrophoretic evidence of seed storage proteins, *P. rotundatus* seems to share phylogenetic affinities with species such as *P. marechalii, P. jaliscanus*, perhaps even with *P. novoleonensis*. Since Lima bean (lane 2) is the type species of the section *Paniculati* (Freytag & Debouck 2002), one would expect more similarities with other members of *Paniculati* (viz. *P. rotundatus, P. marechalii, P. jaliscanus*). This result confirms those of a study on an intergenic section of cpDNA using PCR-RFLP (Fofana et al. 1999), where *P. rotundatus* (= NI 1046) is shown to be close to *P. ritensis* Jones and *P. reticulatus* Freytag & Debouck (= NI 702), both of which are related to *P. marechalii*. Preliminary results of ITS sequencing (Gaitán et al. 2000) indicated a close proximity between *P. rotundatus* and *P. jaliscanus* and *P. acinaciformis* Freytag & Debouck. In a combined analysis of the nuclear ribosomal DNA ITS region and of the chloroplast DNA intron *trnK*, Delgado et al. (2006) have shown the close phylogenetic proximity between the *Paniculati* and the *Coriacei*.

As recognized by Freytag and Debouck (2002) and Delgado et al. (2006), the *Paniculati* seems to be the section of the genus with the largest number of species, and thus is of special interest to breeders of Lima bean given the possibilities for wide crossing (Baudoin 1990). The base for further progress lies first in the proper botanical identification of this biological asset and its conservation. From the review of the *Paniculati* carried out so far, clearly not all taxonomical problems are solved, but we hope to have herein advanced one step further for one of them, *P. rotundatus*.

ACKNOWLEDGMENTS

This work initiated in the fall of 1978 has been made possible thanks to generous grants from CIAT, INIA of Mexico, the University of Guadalajara (the latter for continuing field work in western Mexico), BMZ of Germany, and the World Bank for the visit of one of us to the U.S. National Arboretum. The continuing help of Orlando Toro for keeping track of all data and specimens over years has been immensely valuable to our research. The help of José Alejandro Arroyave and Camilo Oliveros for the scanning electron micrographs and the setting of the figures, respectively, is particularly appreciated. The authors desire to warmly thank Dr George Freytag for his continuing support and interest during all these years of additional observations on the poorly known bean species. The comments made by the Reviewers were particularly appreciated. One of us (DGD) would like to express his deepest gratitude to the Curators of the following herbaria (that keep specimens of section *Paniculati*; see Debouck 2009): A, AGUAT, AHUC, BAA, BAFC, BM, BR, BRIT, CAS, CHAPA, CICY, COL, CORD, CPUN, CR, CUZ, DAV, DES, DS, EBUM, ENCB, F, FI, G, GH, HAO, HNMN, HUT, IBUG, IEB, INB, K, L, LL, LIL, LPB, M, MA, MEXU, MICH, MO, MOL, MSC, NA, NEBC, NY, O, OXF, P, PH, PRG, QCA, SI, TEX, UC, US, USJ, USM, WIS, who allowed him to study their collections 'in situ'.

REFERENCES

Anonymous. 1966. Royal Horticultural Society Colour Chart. The Royal Horticultural Society, London. Fans 2, 3, and 4.

Baudoin, J.P. 1990. L'amélioration de *Phaseolus lunatus* L. en zones tropicales. 6. Réservoirs génétiques, travaux de sélection, conclusions et perspectives. Bull. Rech. Agron. Gembloux 25:395–442.

Brown, J.W.S., Y. Ma, F.A. Bliss, and T.C. Hall. 1981. Genetic variation in the subunits of globulin-1 storage protein of French bean. Theor. Appl. Genet. 59:83–88.

Castilleja, G., D. Evans, and S. Eggen-McIntosh. 1996. Mexico. In: C.S. Harcourt and J.A. Sayer, eds. The conservation atlas of tropical forests. The Americas. International Union for Conservation of Nature and Natural Resources, Simon & Schuster, New York, New York, USA. Pp. 193–205.

Chacón, M.I., B. Pickersgill, and D.G. Debouck. 2005. Domestication patterns in common bean (*Phaseolus vulgaris* L.) and the origin of the Mesoamerica and Andean cultivated races. Theor. Appl. Genet. 110:432–444.

Debouck, D.G. 1983. Observations sur les processus de floraison et de ramification chez quelques *Phaseolus*. Comp. Rend. Séances Acad. Sci., Sér. 3, Sci. Vie 296:425–428.

Debouck, D.G. 2009. Cahiers de phaséologie: section *Paniculati*. International Center for Tropical Agriculture (CIAT), Cali, Colombia. Accessed on line on 7 April 2009 at http://www.ciat.cgiar.org/urg. 261p.

Delgado Salinas, A.O. 2000. New Species of Mexican *Phaseolus* (Fabaceae). Syst. Bot. 25:414–436.

Delgado Salinas, A., R. Bibler, and M. Lavin. 2006. Phylogeny of the genus *Phaseolus* (Leguminosae): a recent diversification in an ancient landscape. Syst. Bot. 31:779–791.

Fofana B., JP Baudoin, X Vekemans, DG Debouck, and P. du Jardin. 1999. Molecular evidence for an Andean origin and a secondary gene pool for the Lima bean (*Phaseolus lunatus* L.) using chloroplast DNA. Theor. Appl. Genet. 98:202–212.

Freytag G.F. and D.G. Debouck. 2002. Taxonomy, distribution, and ecology of the genus *Phaseolus* (Leguminosae-Papilionoideae) in North America, Mexico and Central America. Sida Bot. Misc. 23:1–300.

Gaitán, E., O. Toro, J. Tohme, and D.G. Debouck. 2000. Molecular taxonomy of the genus *Phaseolus* through ITS sequencing. Annual report. Centro Internacional de Agricultura Tropical, Cali, Colombia. Pp. 56–60.

Gepts, P., T.C. Osborn, K. Rashka, and F.A. Bliss. 1986. Phaseolin protein variability in wild forms and landraces of the common bean (*Phaseolus vulgaris* L.): evidence for multiple centers of domestication. Econ. Bot. 40:451–468.

Kwak, M., J.A. Kami, and P. Gepts. 2009. The putative Mesoamerican domestication center of *Phaseolus vulgaris* is located in the Lerma-Santiago basin of Mexico. Crop Sci. 49:554–563.

Maréchal, R., J. Mascherpa, and F. Stainier. 1978. Etude taxonomique d'un groupe complexe d'espèces des genres

Phaseolus et *Vigna* (Papilionaceae) sur la base de données morphologiques et polliniques, traitées par l'analyse informatique. Boissiera 28:1–273.

McVaugh, R. 1987. Flora Novo-Galiciana—A descriptive account of the vascular plants of western Mexico—Volume 5 Leguminosae. The University of Michigan Press, Ann Arbor, Michigan, U.S.A.

Salcedo, J., J.A. Arroyave, O. Toro, and D.G. Debouck. 2006. *Phaseolus novoleonensis*, a new species (Leguminosae, Phaseolinae) from the Sierra Madre Oriental, Nuevo León, Mexico. Novon 16:105–111.

Toledo, V.M. and M.J. Ordoñez. 1993. The biodiversity scenario of Mexico: a review of terrestrial habitats. In: T.P. Ramamoorthy, R. Bye, A. Lot, and J. Fa, eds. Biological diversity of Mexico: origins and distribution. Oxford University Press, New York, New York, U.S.A. Pp. 757–777.

Toledo, V.M., J. Rzedowski, and J. Villa-Lobos. 1997. Regional overview: Middle America, Mexico. In: S.D. Davis, V.H. Heywood, O. Herrera-Macbryde, J. Villa-Lobos, and A.C. Hamilton, eds. Centres of plant diversity—A guide and strategy for their conservation, vol. 3 The Americas. World Wide Fund for Nature and International Union for Conservation of Nature and Natural Resources, Cambridge, United Kingdom. Pp. 97–107.

Zizumbo, D., R. Papa, M. Hufford, S. Repinski, and P. Gepts. 2009. Identification of new wild populations of *Phaseolus vulgaris* in western Jalisco, Mexico, near the Mesoamerican domestication center of common bean. Ann. Rept. Bean Improv. Coop. (U.S.A.) 52:24–25.

DISCOVERY OF A LEWIS AND CLARK GRASS COLLECTION, *POA SECUNDA* (POACEAE) SENSU LATO, AT THE HERBARIUM OF THE ROYAL BOTANIC GARDENS, KEW

Jacques Cayouette
National Program on Environmental Health – Biodiversity
Agriculture and Agri-Food Canada
Wm. Saunders Building (#49)
Central Experimental Farm
Ottawa, Ontario, CANADA K1A 0C6
jacques.cayouette@agr.gc.ca

James L. Reveal
L.H. Bailey Hortorium Herbarium
Department of Plant Biology
Cornell University
Ithaca, New York 14853-4301, U.S.A.
jlr326@cornell.edu

Gary E. Moulton
University of Nebraska
Lincoln, Nebraska 68588, U.S.A.
gmoulton@unl.edu

ABSTRACT

The 2005 discovery of a specimen of *Aira brevifolia* Pursh (=*Poa secunda* J. Presl) at the Royal Botanic Garden Kew (K) collected during the 1804–1806 Lewis and Clark expedition demonstrated that the designated lectotype in the Lewis and Clark Herbarium at the Academy of Natural Sciences in Philadelphia (PH-LC) is a mixture of a June 1806 collection made in Idaho and a late July 1806 collection obtained in Montana. Accordingly, a "second step" lectotypification is proposed for the PH-LC sheet restricting application of *A. brevifolia* to the element Pursh had at hand in London, namely plants collected by Lewis probably near the mouth of Crow Coulee, Chouteau County, Montana, on 28 Jul 1806.

RESUMEN

El descubrimiento en 2005 de un espécimen de *Aira brevifolia* Pursh (=*Poa secunda* J. Presl) en el Royal Botanic Garden Kew (K) colectada durante la expedición de Lewis y Clark en 1804–1806 demostró que el lectotipo designado en el Herbario Lewis and Clark en la Academia de Ciencias Naturales en Filadelfia (PH-LC) es una mezcla de la colección de junio de 1806 hecha en Idaho y una colección de finales de julio de 1806 de Montana. De acuerdo con esto, se propone una lectotipificación "segundo paso" para el pliego PH-LC restringiendo la aplicación de *A. brevifolia* para el elemento que Pursh tuvo a mano en Londres, concretamente plantas colectadas por Lewis probablemente cerca de la boca de Crow Coulee, condado de Chouteau, Montana, el 28 de Julio de 1806.

INTRODUCTION

In September 2005 while visiting the herbarium of the Royal Botanic Gardens at Kew (K), the first author discovered a collection labelled *Aira brevifolia* Pursh (Fig. 1) in a *Deschampsia cespitosa* folder (Merritt et al. 2006). It bears labels and annotations congruent with previously detected Lewis and Clark specimens at K by Ewan (1979) and Moulton (1999), but had not been seen by Ewan, Moulton, or botanists investigating the Lewis and Clark collections examined by Frederick Traugott Pursh (1774–1820) in the preparation of his flora (Pursh 1813). Only about ten or eleven Lewis and Clark specimens were known to be at K (Ewan 1979; Moulton 1999; Reveal et al. 1999; McCourt & Spamer 2004a), these having been obtained indirectly at auction by William J. Hooker (1785–1865) in 1842 (Miller 1970).

RESULTS AND DISCUSSION

Features of the Kew and PH Specimens, and Historical Background

The Kew *Aira brevifolia* collection has four features typical of Lewis and Clark specimens found at K: 1) a label in Pursh's hand with the locality and the date: "Doubtfull River Missouri plains Jul. 28. 1806" (Fig. 1A), thus indicating a Meriwether Lewis collection; 2) annotations by Aylmer Bourke Lambert (1761–1842),

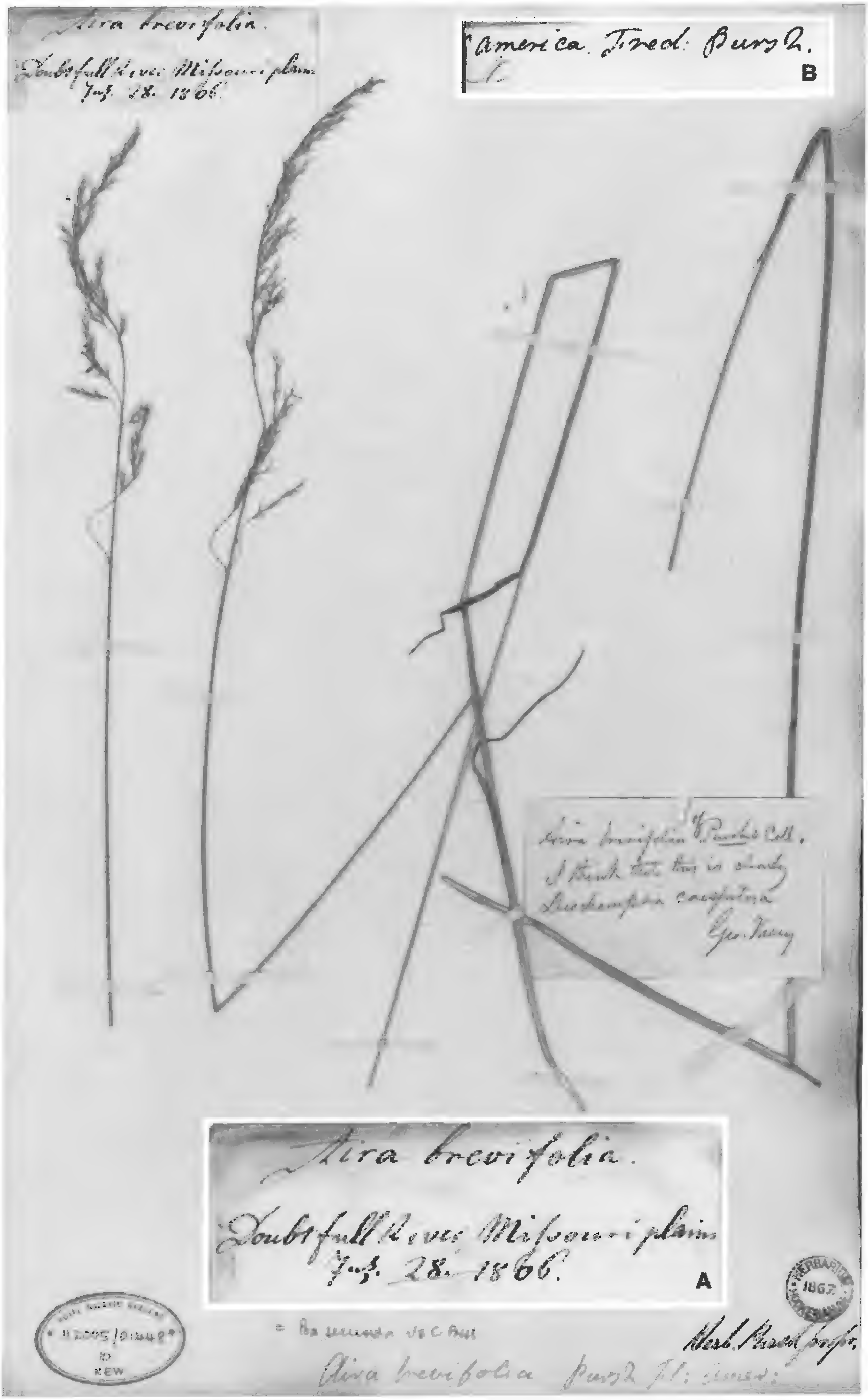

Aira brevifolia.
Doubtfull River Missouri plains
Jul. 28. 1866.
America. Fred: Pursh.
B
Aira brevifolia Pursh's Coll.
I think that this is clearly
Deschampsia caespitosa
Geo. Vasey
Aira brevifolia.
Doubtfull River Missouri plains
Jul. 28. 1866.
A
KEW
1867
= Poa secunda J & C Presl
Herb. Pursh propr.
Aira brevifolia Pursh Fl: Amer:

Fig. 1. A collection of *Aira brevifolia* at K, recently discovered to have been collected during the Lewis and Clark expedition. The plant, *Poa secunda* sensu lato, was collected in Chouteau County, Montana, by Meriwether Lewis; A, Pursh's label enlarged; B, annotation of Aylmer Bourke Lambert.

protector and patron of Pursh, one on the front of the sheet: "*Aira brevifolia* Pursh Fl: Amer." and one on the back: "[N.] America Fred. Pursh" (Fig. 1B); 3) an annotation by William Pamphlin (1806–1899), a bookseller and editor: "Herb. Pursh proper"; and 4), an Hb Hooker stamp. An undated annotation by George Vasey (Fig. 1) (1822–1893), an American grass family specialist who identified the specimen as "*Deschampsia caespitosa*" (sic), is one of the reasons why the specimen was filed in *Deschampsia* and not detected previously (Merritt et al. 2006). *Aira* and *Deschampsia* were once considered to be related genera and some of the species were placed in *Aira* by some, and in *Deschampsia* by others (see for example, Hitchcock 1920).

Nevertheless, the collection is correctly identified as the *Poa secunda* J. Presl group (annotated by J. Cayouette and S.J. Darbyshire in 2005). In fact, as the specimen has most of its spikelets shattered, it was not recognized easily as a *Poa* species. The shattered state of the spikelets of the *P. secunda* specimen is congruent with its having been collected late in the season, on July 28, 1806. On that day, a Monday, Lewis and his men were in western Montana near today's Fort Benton. In the morning they were in Chouteau County, close to the Missouri River, after retreating from the Blackfeet Indians for three days (they killed two in the only "battle" of the expedition; see Moulton 1993). They were fatigued but determined to reach the river. When they heard rifle fire, they assumed it was Sergeant Patrick Gass and his party bringing the canoes down river. They reached the Missouri River, still in Chouteau County, and the two groups joined up that afternoon. From near the mouth of the Marias River they journeyed downstream about fifteen miles and camped.

It is difficult to determine exactly where Lewis collected the plant. Also uncertain is the "Doubtful River" reported on the label (Fig. 1A), probably transcribed by Pursh from an annotation by Lewis that is now lost. This location is not mentioned in the journals nor is it shown on Clark's maps, but might refer to the area near the mouth of Crow Coulee (Chouteau County, see Merritt et al. 2006) which would have been a "Doubtful River."

The main Lewis and Clark plant collections are at the herbarium of the Academy of Natural Sciences of Philadelphia (PH-LC) and have been fully documented (Moulton 1999; Reveal et al. 1999; McCourt & Spamer 2004a, b; Spamer & McCourt 2004). When Pursh went to London in 1811, he brought some of Lewis's plants, most probably those he thought were new to science (Reveal et al. 1999; McCourt & Spamer 2004b) to prepare his *Flora Americae Septentrionalis* that was published in late December 1813. The numbers of Lewis and Clark specimens he brought with him are not known but probably there were about 50, representing approximately 25% of the entire Lewis and Clark collection (McCourt & Spamer 2003).

After the publication of his flora, Pursh returned to North America (Canada) and left his specimens with A.B. Lambert who kept them in his personal herbarium in London. After Lambert's death in 1842, his herbarium was auctioned off, with Pursh's specimens placed in at least two lots (Miller 1970; Moulton 1999). The one acquired by the botanist Edward Tuckerman (1817–1886) contained many of Lewis's specimens, and they eventually found their home in Philadelphia along with the other collections stored at the American Philosophical Society that were recovered in 1897. An unknown number of Lewis's plants were mixed with the Pursh herbarium in a lot that was acquired by Pamphlin. The Pursh plants came later to W.J. Hooker and became the property of Kew in 1867 when Hooker's herbarium was purchased by Kew. Joseph Ewan discovered the Lewis specimens at Kew (Ewan 1979).

Most of the ten or eleven collections authoritatively attributed to Lewis are duplicates of specimens retained in Philadelphia and now part of PH-LC. The Philadelphia collections include type species described by Pursh in his flora. Most of the Kew duplicates bear a Pursh label and share the same date and locality, but this is not the case with the PH-LC counterpart of *Aira brevifolia* (Fig. 2). Until recently only one collection from the Lewis and Clark expedition could be associated with *Aira brevifolia*, PH-LC 170. On that sheet the label written by Pursh reads: "The most common grass through the plains of Columbia & near the Kooskooskee [Clearwater] R. Jun: 10th 1806." Pursh added: "*Poa trivialis* L. var." The name of *Aira brevifolia* was not written by Pursh on the sheet but added by Thomas Meehan (1826–1901, fide Moulton 1999, fig. 133 and transcription of the annotations) probably in 1897. That specimen was reported to have been collected in

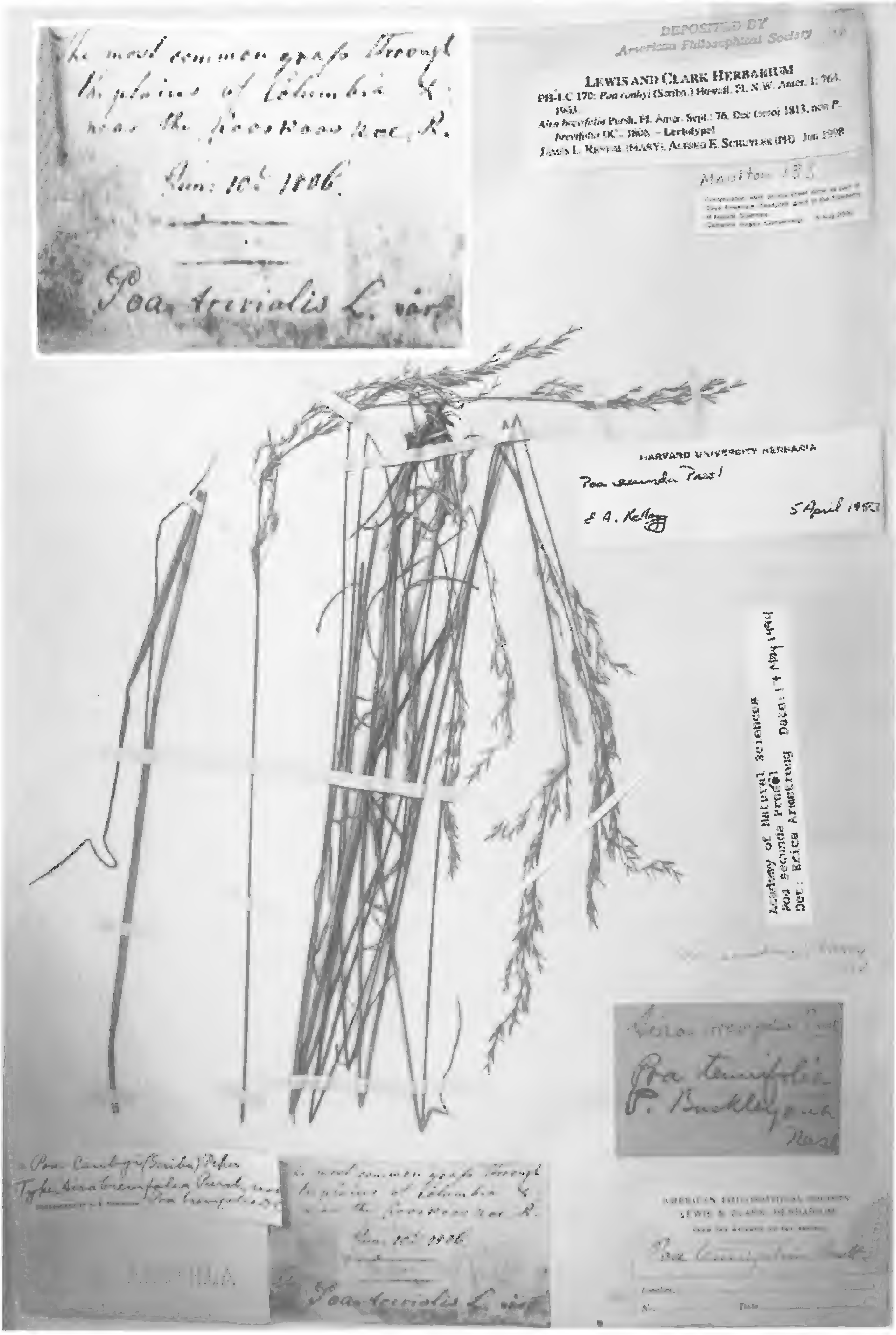

the most common grass through the plains of Columbia & near the Kooskooskee R.
Jun: 10th 1806.
Poa trivialis L. var.
DEPOSITED BY American Philosophical Society
LEWIS AND CLARK HERBARIUM
PH-LC 170: Poa cusickii (Scribn.) Hitchc.
Aira brevifolia Pursh, Fl. Amer. Sept.: 76. Dec 1813, non P. brevifolia DC., 1805 – Lectotype!
James L. Reveal (MARY), Alfred E. Schuyler (PH) Jun 1998
HARVARD UNIVERSITY HERBARIA
Poa secunda Presl
E. A. Kellogg
5 April 1983
Academy of Natural Sciences
Poa secunda Presl
Det: Erica Armstrong Date: 14 May 1994
Poa tenuifolia
P. Buckleyana
Nash
Type Aira brevifolia Pursh
Poa trivialis L. var.
AMERICAN PHILOSOPHICAL SOCIETY
LEWIS & CLARK HERBARIUM
Locality
No.
Date

Fig. 2. Lectotype of *Aira brevifolia* Pursh (PH-LC 170) representing *Poa secunda* sensu lato collected in Idaho County, Idaho, by Meriwether Lewis; Pursh's label enlarged at the top left of the sheet.

Idaho County, Idaho (Moulton 1999; Reveal et al. 1999) and was identified as belonging to the *Poa secunda* group (Hitchcock 1935; Cutright 1969; Ewan 1979; Moulton 1999; Reveal et al. 1999; Soreng 2003).

Clarification of the Lectotypification

It seems likely that the PH-LC collection consists of portions of both the Idaho and Montana collections (Fig. 2) for the second left hand specimen (with a bent panicle) most closely resembles the specimens on the K sheet, while the large clump to the right has roots and mature (not shattered) spikelets, and seems to correspond to collections made earlier (June 10). The K panicles, with mostly brown and shattered spikelets, clearly correspond to a later collection (July 28). A fragment of the PH-LC lectotype is present in the US herbarium (US-76299) and was reported in Soreng (2003: 90). A.S. Hitchcock and A. Chase used to obtain fragments of type material of North American grasses and they were deposited in US as reference specimens (Hitchcock 1935). According to R.J. Soreng (pers. comm. 2006), the fragment of the panicle of the US-76299 bears brown spikelets. An examination of the spikelets of the two supposed groups of specimens on the PH-LC sheet did not reveal a difference in color (A.E. Schuyler, pers. comm. 2006). At this time, it is not known from which group of panicles of the PH-LC sheet the panicle fragment at US originated and therefore its type status is in question.

Aira brevifolia Pursh was described from specimens Frederick Pursh obtained from Meriwether Lewis who collected them during the Lewis and Clark expedition of 1804–1806 (Pursh, *Fl. Amer. Sept.*: 76, sero 1813). Following his description, Pursh indicated: "In the plains of Missouri. *M. Lewis.* June, July. *v.s. in Herb. Lewis.* This grass is the most common in those plains." Unaware of the existence of the K specimen of *Aira brevifolia*, Cutright (1969: 401) selected PH-LC 170 as a lectotype (as "type") for *Aira brevifolia* and it was considered as such by Reveal et al. (1999: 39).

The PH-LC and the K specimens represent the same taxon, *Poa secunda* J. Presl, so Pursh's description (protologue) applies to both specimens. It seems evident that Pursh saw the two specimens and transcribed Lewis' annotations of the labels; this is why June and July appear in the protologue. The PH-LC specimen remained in Philadelphia while the K sheet was brought by Pursh to London in 1811 where he prepared his flora (Moulton 1999). So Pursh had the K specimen before him when he described *Aira brevifolia* but not PH-LC 170. Pursh personally wrote *Aira brevifolia* on the K label (Fig. 1A), and the specimen has fewer and shorter leaves (*brevifolia*) than the PH-LC specimens. Pursh did not inscribe "*Aira brevifolia*" on the PH-LC specimen but rather "*Poa trivialis* L. var." Clearly, his decision to recognize a new species was made after he left Philadelphia in 1809. While the two collections from Idaho and Montana taxonomically represent the same taxon, PH-LC 170 remains the lectotype of *Aira brevifolia* even if the K specimen would have made a more suitable choice.

Nonetheless, as noted here, the PH-LC sheet is a mixture of two collections, one made in Idaho in June of 1806 and a second obtained in Montana in July of 1806. Although the designation of the PH-LC as the lectotype cannot be altered, it is necessary to restrict application of the name to one of the two discordant elements. Accordingly, we hereby restrict the lectotype to just a portion of the PH-LC specimen and designate here (hoc loc.) as the lectotype the following element: *Lewis s.n.*, "Doubtfull River Missouri plains," probably near the mouth of Crow Coulee, Chouteau County, Montana, 28 Jul 1806, PH-LC-170, the second left hand specimen with a bent panicle. A duplicate of the lectotype is at K.

CONCLUSION

Numerous grasses were seen by Lewis and Clark in the open areas of the prairie habitats and some were actually collected by Lewis because of their obvious or potential economic importance (Earle & Reveal 2003). It is not clear why Lewis would have collected such a common and widespread grass as Sandberg's bluegrass (*Poa secunda*), but it probably was because the seeds were readily available, and he needed a voucher specimen to go with the seeds. There might be at least another reason for this collection. By late July 1806 Lewis knew that all of his 1805 plant collections cached in Montana before crossing the Rocky Mountains (save one, a *Ribes*) were lost, and obtaining a grass may have been an attempt to acquire a more diverse collection. Lewis continued to collect, albeit rarely, going down river until he was accidentally wounded on 11 August (Moulton 1993).

As previously recorded, some of the K specimens of the Lewis and Clark expedition are duplicates of the PH-LC ones (Ewan 1979; Moulton 1999; Reveal et al. 1999). Interestingly, according to Moulton (1999), there are seven specimens found at K that have no counterpart at PH-LC. A search for other potential Lewis and Clark authentic specimens has been intensive at these herbaria and elsewhere, and most of the possibilities have been documented, discussed, and resolved (Moulton 1999; Reveal et al. 1999).

On the other hand, despite a careful search at K by Moulton, Ewan and others investigating the Lewis and Clark collections examined by Pursh, a grass collection of *Poa secunda* sensu lato was still there and unrevealed. Is it possible that other Lewis and Clark collections brought by Pursh to London in 1811 are still undetected within the seven million specimens of the K herbarium, one of the largest of its kind in the world? Even if browsing the North American folders at K may represent a monumental task, it may lead to tracing lost or unknown Lewis and Clark specimens. With the eventual data basing of the K herbarium, such a search would be facilitated, but the largest herbaria are likely to be the last ones to have such documentation.

ACKNOWLEDGMENTS

We wish to thank J. Marsden, T. Cope, and S. Owens (K) for the loan of the Kew specimen, C. Kiel and L.A. McDade (PH) for respectively the scanning and the permission to reproduce the PH-LC specimen, R.J. Soreng (US) for his examination of the US fragment, A.E. Schuyler (PH) for examination of the spikelets of the PH-LC specimens, G. Mitrow (DAO) for the scanning of the K specimen, and J. McCarthy and E. Johnson for preparation of the figures. The K specimen was reproduced with kind permission of the Director and Board of Trustees, Royal Botanic Gardens, Kew. We thank Bernard R. Baum, Venice Bayrd, Stephen J. Darbyshire, Ernest Small, and an anonymous reviewer for their constructive comments on earlier drafts.

REFERENCES

Cutright, P.R. 1969. Lewis and Clark: pioneering naturalists. University of Illinois Press, Urbana.

Earle, A.S. and J.L. Reveal. 2003. Lewis and Clark's green world. The expedition and its plants. Farcountry Press, Helena, MT.

Ewan, J.A. 1979. Introduction to the facsimile reprint of Frederick Pursh's Flora Americae Septentrionalis (1814). In: F.T. Pursh, Flora Americae Septentrionalis (facsimile reprint, J. Cramer, Vaduz). Pp. 7–117.

Hitchcock, A.S. 1920. The genera of grasses in the United States, with special reference to the economic species. U.S.D.A., Bull. 772.

Hitchcock, A.S. 1935. Manual of the grasses of the United States. U.S.D.A., Misc. Publ. 200.

McCourt, R.M. and E.E. Spamer. 2003. The botanical legacy of Lewis and Clark: the most famous collection you never heard of. Pl. Sci. Bull. 49:126–131.

McCourt, R.M. and E.E. Spamer. 2004a. On the paper trail in the Lewis and Clark herbarium. Bartonia 62:1–24.

McCourt, R.M. and E.E. Spamer. 2004b. Jefferson's botanists: Lewis and Clark discover the plants of the West. Academy of Natural Sciences, Philadelphia.

Merritt, J.L., J. Cayouette, J.L. Reveal, and G.E. Moulton. 2006. Lewis & Clark plant specimen found in London. We Proceeded On (Lewis and Clark Trail Heritage Foundation) 32(1):12.

Miller, H.S. 1970. The herbarium of Aylmer Bourke Lambert: notes on its acquisition, dispersal, and present whereabouts. Taxon 19:492–497.

Moulton, G.E. (ed.). 1993. The journals of the Lewis and Clark expedition. June 10–September 26, 1806. Vol. 8. University of Nebraska Press, Lincoln.

Moulton, G.E. (ed.). 1999. The journals of the Lewis and Clark expedition. The herbarium of the Lewis and Clark expedition. Vol. 12. University of Nebraska Press, Lincoln.

Pursh, F.T. 1813. Flora americae septentrionalis. 2 vols. White, Cochrane, and Co., London.

Reveal, J.L., G.E. Moulton, and A.E. Schuyler. 1999. The Lewis and Clark collection of vascular plants: names, types, and comments. Proc. Acad. Natl. Hist. Philadelphia 149:1–64.

Soreng, R.J. 2003. *Aira* L. In: Soreng, R.J., P.M. Peterson, G. Davidse, E.J. Judziewicz, F.O. Zuloaga, T.S. Filgueiras, and O. Morrone. Catalogue of New World grasses (Poaceae): IV. Subfamily Pooideae. Edited by R.J. Soreng. Contr. U.S. Natl. Herb. 48:89–96.

Spamer, E.E. and R.M. McCourt. 2004. The second two hundred years are better: the endearing, enduring plants of Lewis and Clark. Bartonia 62:95–102.

BOOK REVIEW

RICHARD A. MINNICH. 2008. **California's Fading Wildflowers: Lost Legacy and Biological Invasions.** (ISBN 978-0-520253537, hbk.). University of California Press, 2120 Berkeley Way, Berkeley, California 94704-1012, U.S.A. (**Orders:** www.ucpress.edu or California-Princeton Fulfillment Services, 1445 Lower Ferry Road, Ewing, New Jersey 08618, U.S.A., orders@cpfsinc.com, 1-800-777-4726). $49.95, 360 pp., 55 illustrations (23 b&w photographs, 13 line illustrations, 19 tables), 6" × 9".

Contents:

1. The Golden State
2. Pre-Hispanic Herbaceous Vegetation
3. Invasion of Franciscan Annuals, Grazing, and California Pasture in the Nineteenth Century
4. A Century of Bromes and the Fading of California Wildflowers
5. Lessons from the Rose Parade

Appendix 1. Location of Franciscan campsites, Franciscan place names, and modern place names
Appendix 2. Spanish plant names for California vegetation
Appendix 3. Selected earliest botanical collections of exotic annual species in California
Appendix 4. References to wildflowers in the Los Angeles Times, The Desert Magazine, and the Riverside Press Enterprise

California's Fading Wildflowers by Richard A. Minnich is a wonderful example of how human development in an area, or in this case, the entire state of California has forever shaped its flora. The book is extremely well researched to illustrate how California was settled from San Diego to San Francisco. It accurately displays how human agricultural practices and use of livestock on the land—in a time when only 200 or so people lived in a given area—still greatly affected the native vegetation from the coast inland to the central valley.

The book goes back to get information on early California from the journals of early explorers and then on into the mid 1800s where the flora really begins to see a shift towards grasses and away from the native wildflowers when cattle took over as the Gold Rush hit the state. The data from plant material then shifts to more modern techniques of taking plant material found within the bricks of old buildings and identifying the flora of the area at a given time period.

Large quantities of the book are dedicated to the beautiful and now protected, California poppy (*Eschscholzia californica*). There are also specific references to the grizzly bear, now extinct in California, which effectively illustrate how important a role conservation and environmental management play in a state that is as geographically diverse and as densely populated as California. Altogether this is an enjoyable read which gives historical insight into how much the state has changed in the last 300 years.—*Rebecca Swadek, Botanical Research Institute of Texas, Fort Worth, Texas 76102-4025, U.S.A.*

PINUS PINCEANA (PINACEAE), NUEVO REGISTRO PARA EL ESTADO DE NUEVO LEÓN, MÉXICO

Susana Favela Lara
Laboratorio de Vida Silvestre
Facultad de Ciencias Biológicas
Universidad Autónoma de Nuevo León
San Nicolás de los Garza, Nuevo León, MÉXICO

Carlos G. Velazco Macías
Parques y Vida Silvestre de Nuevo León
Av. Eugenio Garza Sada No. 6604
Col. Lagos del Bosque
Monterrey, Nuevo León, MÉXICO

Glafiro J. Alanís Flores
Laboratorio de Vida Silvestre
Facultad de Ciencias Biológicas
Universidad Autónoma de Nuevo León
San Nicolás de los Garza, Nuevo León, MÉXICO

RESUMEN

Se registra por primera vez a *Pinus pinceana* para el estado de Nuevo León, México, las poblaciones están ubicadas en la Sierra Madre Oriental, en el municipio de Santa Catarina.

ABSTRACT

This is the first record for *Pinus pinceana* in the state of Nuevo León in northeast México; the populations are located within the Eastern Sierra Madre, in the Santa Catarina municipality.

México ha sido reconocido como el centro con mayor riqueza de especies para el género *Pinus* con un total de 43 (Farjon 1996); *Pinus pinceana* Gordon es uno de estos elementos endémicos dentro del género para México, fue descrita para el centro del país en el siglo XIX (Gordon 1858), hoy en día su distribución conocida abarca los estados de Hidalgo, Querétaro, Zacatecas, San Luis Potosí y Coahuila en centro y noreste de México (Perry 1991; Villarreal 2001). Las poblaciones de dicha especie se encuentran dispersas y no forman un continuo a través de su rango de distribución, aunque son consistentes en cuanto a las características físicas y biológicas en las que se desarrollan (Farjon y Styles 1997; Ledig et al. 2001). La especie no se encuentra reportada para la flora de Nuevo León (Standley 1920; Martínez 1948; Rojas-Mendoza 1965; Capó 1972; Hinton y Hinton 1995).

La especie fue encontrada en Nuevo León por las exploraciones botánicas del Dr. Jorge Armando Verduzco Martínez, alrededor del año 2000, pero su registro no fue publicado y no se colectaron ejemplares de herbario, se dio seguimiento a dichos trabajos de exploración en la parte norte de la Sierra Madre Oriental con la finalidad de documentar formalmente la existencia de dicha especie para el estado, por lo que se realizaron salidas a diversos complejos de cañones ubicados en la zona en cuestión, específicamente en el municipio de Santa Catarina para ubicar las poblaciones de la especie. Una vez ubicadas, se georeferenciaron y delimitaron las poblaciones, se realizaron anotaciones sobre el tipo de vegetación y las especies de flora asociada, así como del medio físico en el que se desarrollan; se colectaron ejemplares para ser depositados en herbarios. Por medio de herramientas geoespaciales ArcView y Google Earth, se elaboró un mapa de distribución para la especie en Nuevo León.

Las poblaciones de *Pinus pinceana* se localizan en el cañón El Montoso, en el municipio de Santa Catarina, a 8 kilómetros en línea recta al suroeste de la cabecera municipal y la zona urbana de la ciudad de Monterrey. Los grupos de individuos se restringen a cañadas y arroyos de laderas con exposición norte dentro del cañón, se presenta una altitud inicial de 1,100 msnm y alcanzan hasta los 1,700 msnm, las poblaciones se extienden cerca de 10 km en dirección oeste de manera intermitente en cada una de las cañadas que

J. Bot. Res. Inst. Texas 3(2): 771 – 774. 2009

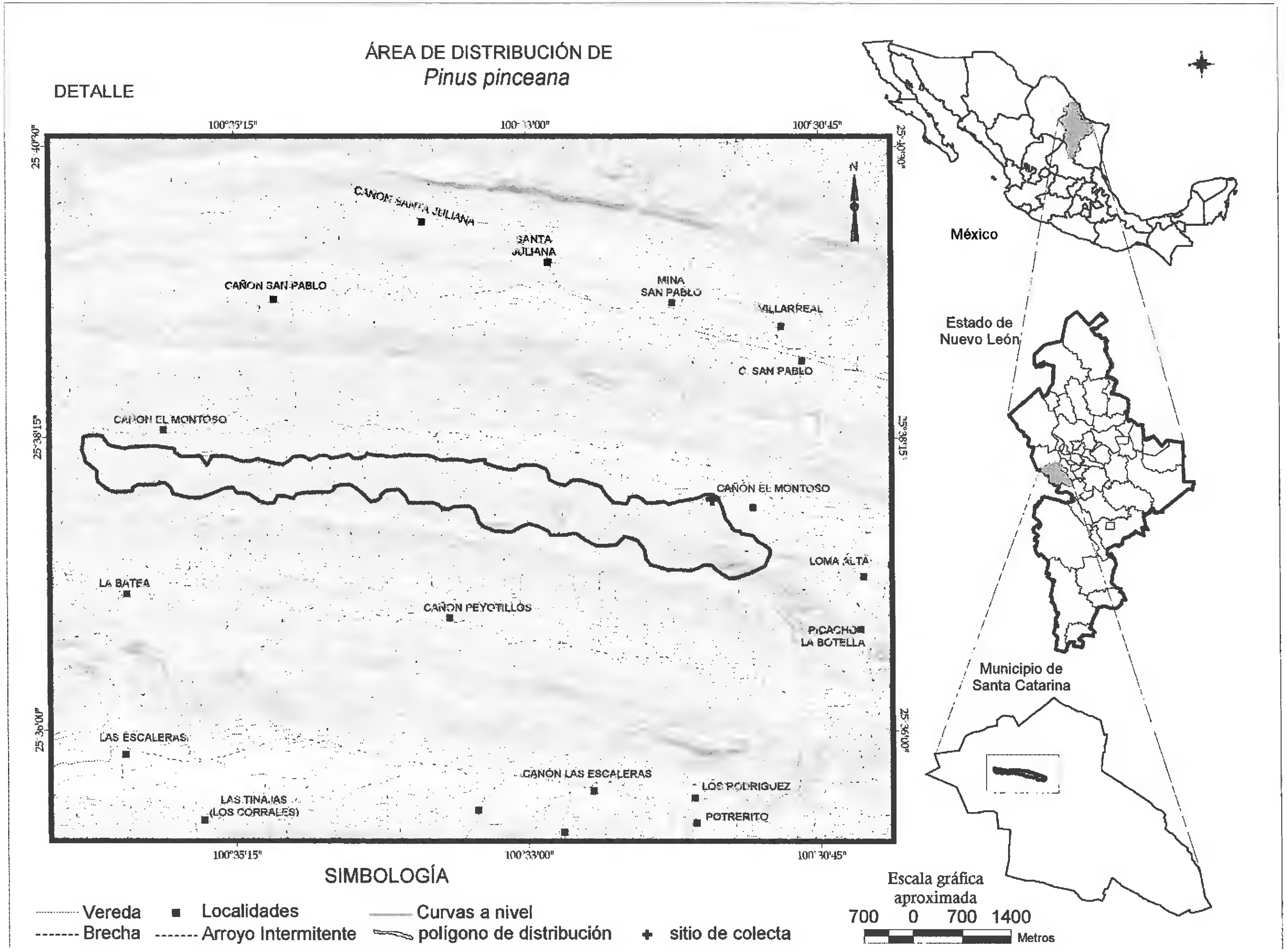

ÁREA DE DISTRIBUCIÓN DE
Pinus pinceana
DETALLE
100°35'15"
100°33'00"
100°30'45"
25°40'30"
25°38'15"
25°36'00"
N
CAÑON SANTA JULIANA
SANTA JULIANA
CAÑON SAN PABLO
MINA SAN PABLO
VILLARREAL
C. SAN PABLO
CAÑON EL MONTOSO
CAÑON EL MONTOSO
LOMA ALTA
LA BATEA
CAÑON PEYOTILLOS
PICACHO LA BOTELLA
LAS ESCALERAS
CAÑON LAS ESCALERAS
LOS RODRIGUEZ
LAS TINAJAS (LOS CORRALES)
POTRERITO
México
Estado de Nuevo León
Municipio de Santa Catarina
SIMBOLOGÍA
Vereda
Brecha
Localidades
Arroyo Intermitente
Curvas a nivel
polígono de distribución
sitio de colecta
Escala gráfica aproximada
700 0 700 1400
Metros

Fig. 1. Distribución de *Pinus pinceana* en el estado de Nuevo León, México.

integran el cañón El Montoso partiendo de la localidad denominada Loma Alta el inicio del cañón (Fig. 1). Se presentan suelos de tipo litosol más rendzina con una clase textural media en los primeros 30 cm del suelo (CETENAL 1977a); la geología se compone de rocas sedimentarias de tipo caliza y calizas más lutitas, así como brecha sedimentaria (CETENAL 1976); el clima es de tipo seco semicálido con lluvias en verano (BS_0hw), la precipitación es de entre 325 y 400 mm durante el verano y de 50 a 75 mm durante el invierno, pueden presentarse heladas durante los meses de noviembre a marzo (Secretaría de Programación y Presupuesto 1981). *P. pinceana* se integra a una vegetación de tipo matorral submontano subinerme y matorral desértico rosetófilo (CETENAL 1977b), donde las especies más comunes son *Acacia greggii* A. Gray (guajillo), *Helietta parvifolia* (A. Gray) Benth. (barreta), *Cordia boissieri* C. DC. (anacahuita), *Acacia rigidula* Benth. (chaparro prieto), *Gochnatia hypoleuca* (DC.) A. Gray (ocotillo), *Mortonia greggii* A. Gray (afinador), *Calia secundiflora* (Gomez-Ortega) Yakovlev (colorín), *Decatropis bicolor* (Zucc.) Radlk. (hoja dorada), *Agave lecheguilla* Torr. (lechuguilla), *Hechtia glomerata* Zucc. (guapilla), *Dasylirion texanum* Scheele (sotol), *Opuntia stenopetala* Engelm. (nopal) y *Echinocereus stramineus* (Engelm.) Rumpler (pitaya de mayo).

Ejemplares de herbario: **MEXICO. Nuevo León. Municipio de Santa Catarina:** Cañón El Montoso, 2 kilómetros al oeste de Loma Alta, 25°37'46.70"N–100°31'34.55"W, 1160 msnm, 17 Feb 2009, *Velazco-Macías y Favela-Lara s.n.* (ANSM, UNL).

Con anterioridad se había ya sugerido la presencia de esta especie en Nuevo León (Martínez 1948), y la ocurrencia de poblaciones de esta especie en la Sierra de Zapalinamé y la Sierra San José de los Nuncios en el estado de Coahuila hacen más factible la ocurrencia de otras poblaciones en el complejo orográfico de la Sierra Madre Oriental entre los límites de Nuevo León y Coahuila. *Pinus pinceana* se encuentra incluido en la norma oficial mexicana NOM-059-SEMARNAT-2001, bajo la categoría de "protección especial" (Pr), y había sido mencionado como parte de la flora en riesgo para el estado de Nuevo León (Alanís et al. 2004); a pesar de su cercanía con la zona metropolitana de Monterrey y la cabecera municipal de Santa Catarina, no se observan amenazas a corto o mediano plazo como la ganadería o el impacto por turismo, sin embargo, el desarrollo urbano y habitacional en la zona si representa una amenaza a lago plazo, cabe resaltar que la especie se encuentra dentro de los límites del Parque Nacional Cumbres de Monterrey, lo cual podría favorecer su conservación y protección.

AGRADECIMIENTOS

Al Biol. Héctor M. Villalón Moreno por su apoyo durante los trabajos de campo; Al Ing. Jorge Martínez Pineda por la generación del mapa de distribución y el procesamiento de la información geográfica; y a la M. en C. Liliana Ramírez Freire por la revisión al manuscrito.

REFERENCIAS

Alanís Flores, G.J., C.G. Velazco Macías, R. Foroughbakhch Porunavav, V. Valdez Tamez y M.A. Alvarado Vazquez. 2004. Diversidad florística de Nuevo León: especies en categoría de riesgo. Ciencia UANL. 7:209–218.

Capó Arteaga, M. 1972. Observaciones sobre la taxonomía y distribución de las coníferas de Nuevo León, México. Tesis de Licenciatura, U.A.N.L. F.C.B. México.

Cetenal. 1976. Carta geológica. Garza García G14C25. Escala 1:50,000. Primera edición. México.

Cetenal. 1977a. Carta edafológica. Garza García G14C25. Escala 1:50,000. Primera edición. México.

Cetenal. 1977b. Carta de uso de suelo. Garza García G14C25. Escala 1:50,000. Primera edición. México.

Farjon, A. 1996. Biodiversity of *Pinus* (Pinaceae) in Mexico: speciation and palaeo-endemism. Bot. J. Linn. Soc. 121:365–384.

Farjon, A. y B.T. Styles. 1997. *Pinus* (Pinaceae). Fl. Neotropica Monogr. 75. The New York Botanical Garden, Bronx.

Gordon, G. 1858. The Pinetum: being a sinopsis of all coniferous plants at present known, with descriptions, populations and synonyms. Henry G. Bohn, London, UK.

Hinton, J. y G.S. Hinton. 1995. Checklist of Hinton's collection of the flora of south-central Nuevo León and adjacent Coahuila. Acta Bot. Mex. 30:41–112.

Ledig, F.T., M.A. Capo Arteaga, P.D. Hodgskiss, H. Sbay, C. Flores Lopez, M.T. Conkle, and B. Bermejo Velazquez. 2001. Genetic diversity and the mating system of a rare Mexican piñon, *Pinus pinceana*, and a comparison with *Pinus maximartinezii* (Pinaceae). Amer. J. Bot. 88:1977–1987.

Martínez, M. 1948. Los Pinos Mexicanos. Segunda edición. Universidad Autonóma de México. México.

Perry, J.P. 1991. The pines of Mexico and Central America. Timber Press, Portland, Oregon.

Secretaría de Programación y Presupuesto. 1981. Carta estatal, climas. Estado de Nuevo León. México.

Standley, P.C. 1920. Tress and shrubs of Mexico (Gleicheniaceae – Betulaceae). Contr. U.S. Natl. Herb. 23(1): 1–170.

Rojas-Mendoza, P. 1965. Generalidades sobre la vegetación del estado de Nuevo León y datos acerca de su flora. Tesis doctoral. Facultad de Ciencias, Universidad Nacional Autónoma de México.

Villarreal Quintanilla, J.Á. 2001. Flora de Coahuila. Listados florísticos de México. Instituto de Biología. Universidad Nacional Autónoma de México. México D.F.

DIVERSIDAD Y DISTRIBUCIÓN DE LAS GRAMÍNEAS (POACEAE) EN EL ESTADO DE ZACATECAS

Yolanda Herrera Arrieta y Armando Cortés Ortiz

Instituto Politécnico Nacional
CIIDIR Unidad Durango COFAA
Sigma 119 Fracc. 20 de Noviembre II
Durango, Dgo., MEXICO, 34220
yherrera@ipn.mx; c_armando25@hotmail.com

RESUMEN

Se analiza la distribución espacial de 284 especies de gramíneas (Poaceae) colectadas en Zacatecas, con el objetivo de revisar la diversidad de esta familia en el estado. Así mismo se estudia la distribución de las especies en cuatro tipos de vegetación y en intervalos altitudinales. Para lograrlo se construyó una cuadrícula regular (de 0.5 por 0.5 grados) en el territorio zacatecano. Se determinó el número de colectas y especies (riqueza de especies), con ayuda del programa Diva-GIS, se estimó el índice de intercambio de especies (diversidad beta) entre los cuadros de Zacatecas, aplicando el índice de Whittaker. Se analizan las tribus más diversas en el estado y se discute su distribución geográfica. Por último se revisan las afinidades geográficas de las gramíneas y se encuentra que el porcentaje de endemismo de esta familia está por debajo de los estimados en reportes previos.

Palabras clave: Gramíneas, Poaceae, patrones de distribución, Zacatecas, México

ABSTRACT

The spatial distribution of 284 species of grasses (Poaceae) from Zacatecas were analyzed in order to check the relative diversity of the family in the state. The distribution of species was studied within four general types of vegetation and altitudinal ranges. The state was divided in squares of 0.5 × 0.5 degrees, where the number of collections and species were placed. We applied the Diva-GIS program (Hijmans 2004) to determine species turnover (Beta diversity) among squares, by using a classification procedure and the Whitaker Index. Geographic distribution of the most diverse tribes in the state was analyzed, as well as geographic affinities of grasses in Zacatecas. The results suggest that endemism percentage of this family is lower than earlier estimates.

INTRODUCCIÓN

Las gramíneas son elementos importantes en la composición florística de varios tipos de vegetación y en ocasiones forman comunidades vegetales denominadas pastizales, donde juegan un papel predominante (Rzedowski 1978). México cuenta con una importante superficie cubierta por pastizales de un 18 a 20 % del territorio (Rzedowski 1978); en Zacatecas un porcentaje similar al del país está cubierto por pastizales naturales, lo que ha permitido que la producción ganadera sea una de las actividades económicas de mayor relevancia en el estado (INEGI 2006). Los pastizales de Zacatecas, además de su reconocida capacidad de producción de ganado vacuno para carne en terrenos de pastoreo extensivo, revisten una gran importancia ecológica por formar parte del continuo de pastizales del SW de Estados Unidos y el NW de México, tratándose de comunidades vegetales cuyo origen y formación se remontan a cerca de 20 millones de años atrás (Bailey 2000). Las actividades humanas de los últimos siglos están causando la desertificación de los pastizales con el sobrepastoreo y la roturación para terrenos de cultivo, además de las sequías prolongadas, fuegos e invasión de especies exóticas que incrementan la vulnerabilidad de estas comunidades.

De las plantas vasculares, la familia de las gramíneas es una de las más grandes y más distribuidas en el mundo, se encuentra desde los círculos polares hasta el ecuador, en las cumbres de las montañas y al nivel del mar (Hitchcock 1951). Por su número de especies se estima que ocupa el cuarto lugar a nivel mundial después de las compuestas, las leguminosas y las orquídeas (Lawrence 1951); en México ocupan el tercer lugar superando en número a las orquídeas (Rzedowski 1978). No obstante, ocupan el primer lugar en cuanto a su importancia económica, ya que pertenecen a esta familia los cereales como el arroz, trigo, maíz y caña de azúcar, base de la alimentación humana. Es la familia de plantas con mayor importancia ecológica

---

J. Bot. Res. Inst. Texas 3(2): 775 – 792. 2009

por su diversidad, por su característica capacidad de formar suelos y porque la mayoría de sus especies son elementos naturales de vegetaciones primarias, aunque también un porcentaje no muy alto de ellas (<5% estimado) han desarrollado la capacidad de dispersarse por el mundo y establecerse como adventicias en hábitats diversos.

Se estima que existen alrededor de 700 géneros y 10,000 especies de gramíneas en el mundo (Clayton & Renvoize 1986), de ellos 204 géneros y 1182 especies se encuentran en México (Dávila et al. 2006). El 44.61% de los géneros y 24% de las especies distribuidas en México se encuentran en el estado de Zacatecas donde recientemente se reportan 91 géneros y 284 especies, 6 subespecies, 30 variedades y 4 formas (Herrera et al. 2009).

La diversidad biológica o biodiversidad es la "variedad de vida" y se refiere de manera general a la variación en todos los niveles de organización biológica. Existen muchas definiciones, DeLong (1996) registra 85 definiciones de la diversidad biológica o biodiversidad. La biodiversidad puede dividirse en tres grupos: 1) diversidad genética, 2) diversidad de organismos vivos y 3) diversidad ecológica (Gaston & Spicer 2007). La diversidad genética abarca los componentes del código genético que estructuran a los organismos (nucleótidos, genes, cromosomas) y la variación de estructura genética entre individuos en el seno de una población y entre poblaciones. La diversidad de organismos abarca la jerarquía taxonómica y sus componentes, desde los individuos hasta categorías taxonómicas de orden superior. La diversidad ecológica abarca las escalas de diferencias ecológicas desde las poblaciones pasando por nichos y hábitats hasta más allá de los biomas (Gaston & Spicer 2007). De manera que la biodiversidad puede ser medida de muchas maneras, en la práctica tiende a ser medida más frecuentemente en términos de riqueza de especies, esto es, por el número de especies. Esta medida de biodiversidad de organismos es muy común debido a su aplicación práctica, información existente, sustitución, aplicación amplia (Gaston & Spicer 2007). La familia de las gramíneas parece ser interesante como un indicador de biodiversidad, por ser un grupo importante en la riqueza florística mexicana, especialmente en la región norte de México (Challenger 1998). Con base en lo anterior se propone llevar a cabo un análisis de la diversidad relativa de organismos y la distribución geográfica de las gramíneas encontradas en 4 tipos de vegetación principales del estado de Zacatecas, con base en datos georreferidos de colectas y del conocimiento actualizado de los taxa que conforman esta familia (Herrera et al. 2009).

MATERIALES Y MÉTODOS

Área de estudio

El estado de Zacatecas se localiza en la porción centro-norte de la República Mexicana. con coordenadas extremas 25.12° a 21.04° N y -104.33° a -100.74° O, rodeado por los estados de Durango, Coahuila, Nuevo León, San Luis Potosí, Jalisco, Aguascalientes y Nayarit, según el Mapa Geoestadístico de México elaborado por INEGI, 1996. El estado de Zacatecas posee un territorio muy irregular en cuanto a su topografía, existen sitios que tienen una altitud de 600 a 700 metros sobre el nivel del mar hasta 3192 metros. Cerca del 75% de su superficie se encuentra en una altitud entre 1800 y 2400 metros, con un máximo en el intervalo de 2000 a 2200, según los datos de altitud (Modelo Digital de Elevación) obtenidos por la misión SRTM (Shuttle Radar Topography Mission) de la NASA (2000). A pesar de las diferencias en altitud, el terreno de Zacatecas tiene pendientes poco pronunciadas, cerca del 75% presenta pendientes menores de 8 grados, según los cálculos realizados con el MDE del SRTM. Las zonas que presentan mayor frecuencia de fuertes pendientes se localizan al sur, suroeste y en el complejo montañoso del norte del estado. Por su fisiografía Zacatecas se divide en las provincias: Mesa Central (44.8%), Sierra Madre Occidental al sur (38.98), Sierra Madre Oriental al norte (15.34%) y Eje Neovolcánico al suroeste (0.85%). Los procesos geohidrológicos han creado en el terreno zacatecano una serie de formas del terreno, llamados sistemas de topoformas en el diccionario de datos fisiográficos, escala 1: 1000,000 (INEGI 1998b), conocidos como llanuras, bajadas, lomeríos, sierras, cañones, mesetas. Siendo las bajadas y las sierras los más comunes en la entidad, seguidos de las llanuras y lomeríos. Por su ubicación geográfica y características topográficas el territorio de

Zacatecas presenta un clima del grupo B [BS_0 seco (30.21%) y BS_1 semiseco (48.34%)], seguido por el grupo C(w) templado subhúmedo (21.16%) y (A)C(w) cálido subhúmedo (0.29%) (INEGI 1980a). Debido a las características climáticas, edáficas y de relieve, la cobertura vegetal del estado está dominado por matorral xerófilo (40%), seguido por pastizal (16%), bosque templado (14%) constituido por latifoliadas y coníferas, bosque tropical (2.5%) y áreas agrícolas (27.5%), esta ultima representa la cuarta parte de la superficie del estado (INEGI 2003).

Materiales

Se utilizaron: a) los registros digitales de los ejemplares de gramíneas colectados en el estado de Zacatecas y existentes en diversos herbarios; b) el marco geoestadístico de la República Mexicana en formato digital elaborado y distribuido por INEGI (1996); c) el conjunto de datos de uso del suelo y vegetación a escala 1:250 000 elaborado por INEGI (2003); y d) el Modelo Digital de Elevación (MDE) generado por la misión SRTM; y e) los Programas de cómputo: Diva-SIG.

Material botánico

Se recopilaron los datos de las colectas realizadas en el estado y depositadas en herbarios mexicanos (CHAPA, CIIDIR, ENCB, HUAZ, IEB, INEGI, MEXU y SLPM) y de Estados Unidos de America (GH, MO, TAES, TEX y US), donde se concentran los ejemplares colectados en el estado durante los últimos 100 años. Estos datos fueron capturados en el sistema Biótica (Base de datos de la CONABIO), con la que se realizó un estudio florístico del estado de Zacatecas (Herrera et al. 2009). Entre los datos de las colectas se incluyó las coordenadas geográficas del sitio, que fueron establecidas a partir de los mapas topográficos de INEGI (1998a) escala 1:250 000.

Métodos

Se realizó un análisis de número de colectas, especies e índice de intercambio mediante la ejecución de los siguientes pasos: 1. Elaboración del mapa estatal con colectas; utilizando el marco geo-estadístico nacional de INEGI (1996), dicho mapa se manejó en coordenadas geográficas. Los sitios de colecta de las especies se sobrepusieron al mapa estatal, por medio de las coordenadas en grados decimales. 2. Elaboración de una cuadrícula; se construyó una cuadrícula regular en el mapa, formada por cuadros de 0.5 por 0.5 grados. Dicha cuadrícula se utilizó para realizar el análisis sobre diversidad, como se indica en las etapas siguientes. 3. Análisis de número de ejemplares y de especies en la cuadrícula; se determinó el número y mapas de las colectas registradas dentro de cada cuadro, así como el número de diferentes especies (diversidad de especies). Esto se realizó con ayuda del programa Diva-GIS. 4. Determinación de la relación de número de colectas y número de especies. La relación de un número de muestras y el número de especies se realizó por medio de una regresión lineal y una regresión logarítmica, por medio de algoritmos incorporados en el programa de aplicación Diva-GIS. 5. Cálculo del índice de intercambio de especies, se estimó un índice de intercambio para conocer cuales cuadros tienen mayor posibilidad de intercambio de especies, para lo que se aplicó el índice de Whitaker $\beta_w = (S/\alpha) - 1$, donde S = número total de especies en las celdas consideradas, α = número promedio de especies en las celdas consideradas. El índice fue calculado con una de las funciones integradas en el programa Diva-SIG. Con la opción "Queen case" que calcula el índice para cada celda considerando sus ocho vecinos (2 horizontales, 2 verticales y 4 diagonales).

El intercambio, también llamado Beta-diversidad, es una medida de intercambio de especies, indica cuan diferentes o similares son un número de áreas cercanas. Dos grandes áreas con número de especies similares, la primera con especies diferentes en todas las celdas de la cuadrícula, y la otra con la misma especie en todos sus cuadros. La primera tendría una elevada diversidad beta, y la segunda tendría una baja diversidad beta (Hijmans et al. 2004).

RESULTADOS

Para llevar a cabo el análisis de diversidad se generó un mapa estatal con una cuadrícula de 30 × 30 minutos (0.5 grados), el número de cuadros fue de 50 como se aprecia en la Figura 1.

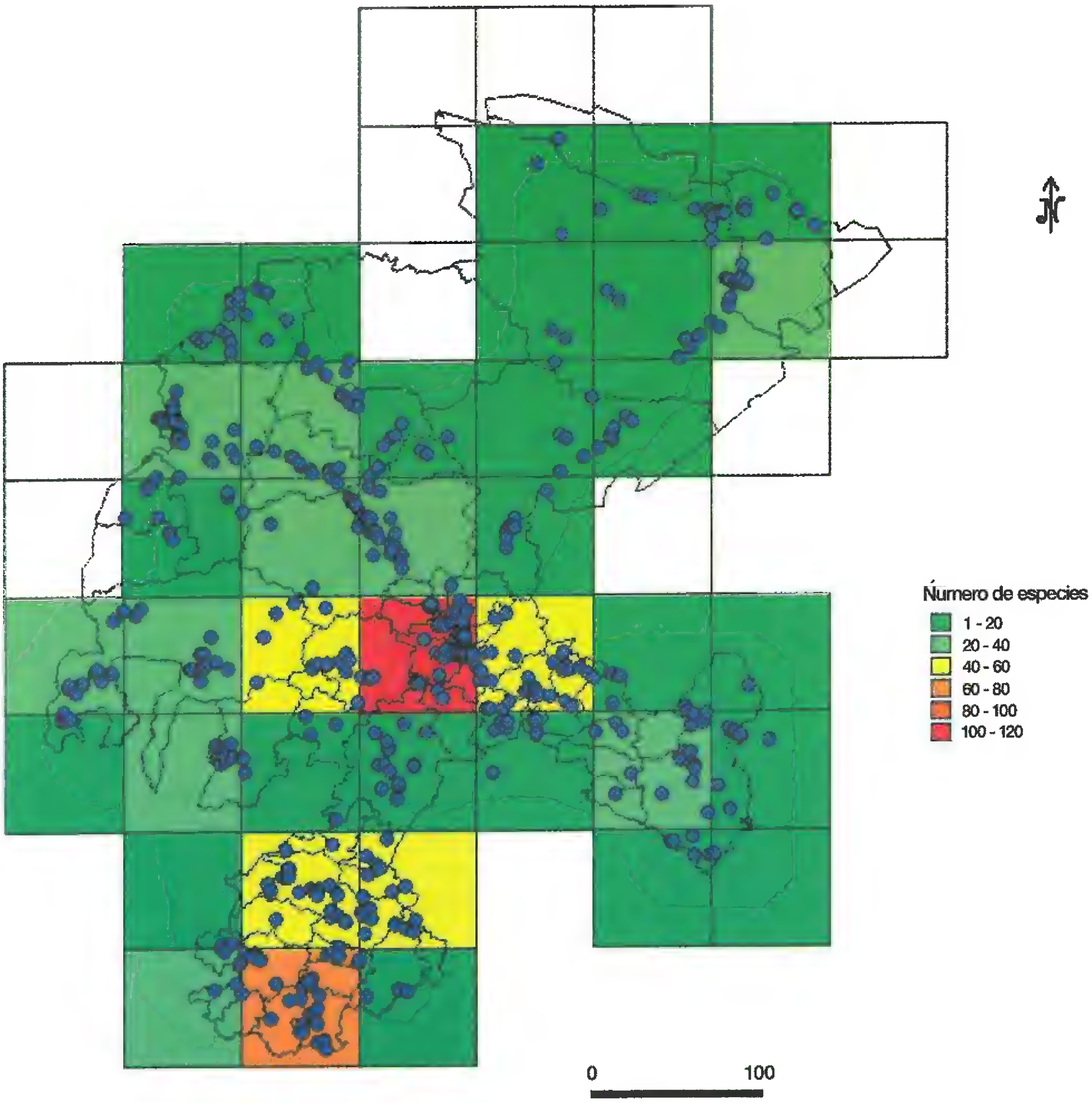


Fig. 1. Mapa con cuadrícula de 0.5° y número de colectas o registros de gramíneas en cada cuadro.

El número de registros (ejemplares de herbario) considerados en este trabajo fue de 2408, cuyos sitios georreferidos de muestreo se indican en la Figura 1. En cada cuadro existe un número distinto de colectas o registros, variando desde 0 a más de 200.

El número (riqueza) de taxa encontrados en cada cuadro también varía desde 0 a más de 100. Es notorio que la cercanía a las ciudades y a las vías de acceso influyen en el número de especies colectadas y presentes (Fig. 2).

Al observar los mapas de las Figuras 1 y 2, se puede apreciar cierta relación entre el número de colectas y el número de especies presentes en cada cuadro, para confirmar esa relación se realizó una regresión lineal entre las dos variables (número de colectas y diversidad), se confirmó que existe esa relación como se puede ver en el gráfico de la Figura 3, donde la regresión lineal tiene un Coeficiente de correlación (r^2) de 0.9498.

En la regresión logarítmica muestra poca relación entre ambas variables (número de colectas y diversidad), esto se puede apreciar fácilmente por la distribución de los puntos en relación a línea de la gráfica de la Figura 4, donde la regresión logarítmica tiene un Coeficiente de correlación (r^2) de 0.7627.

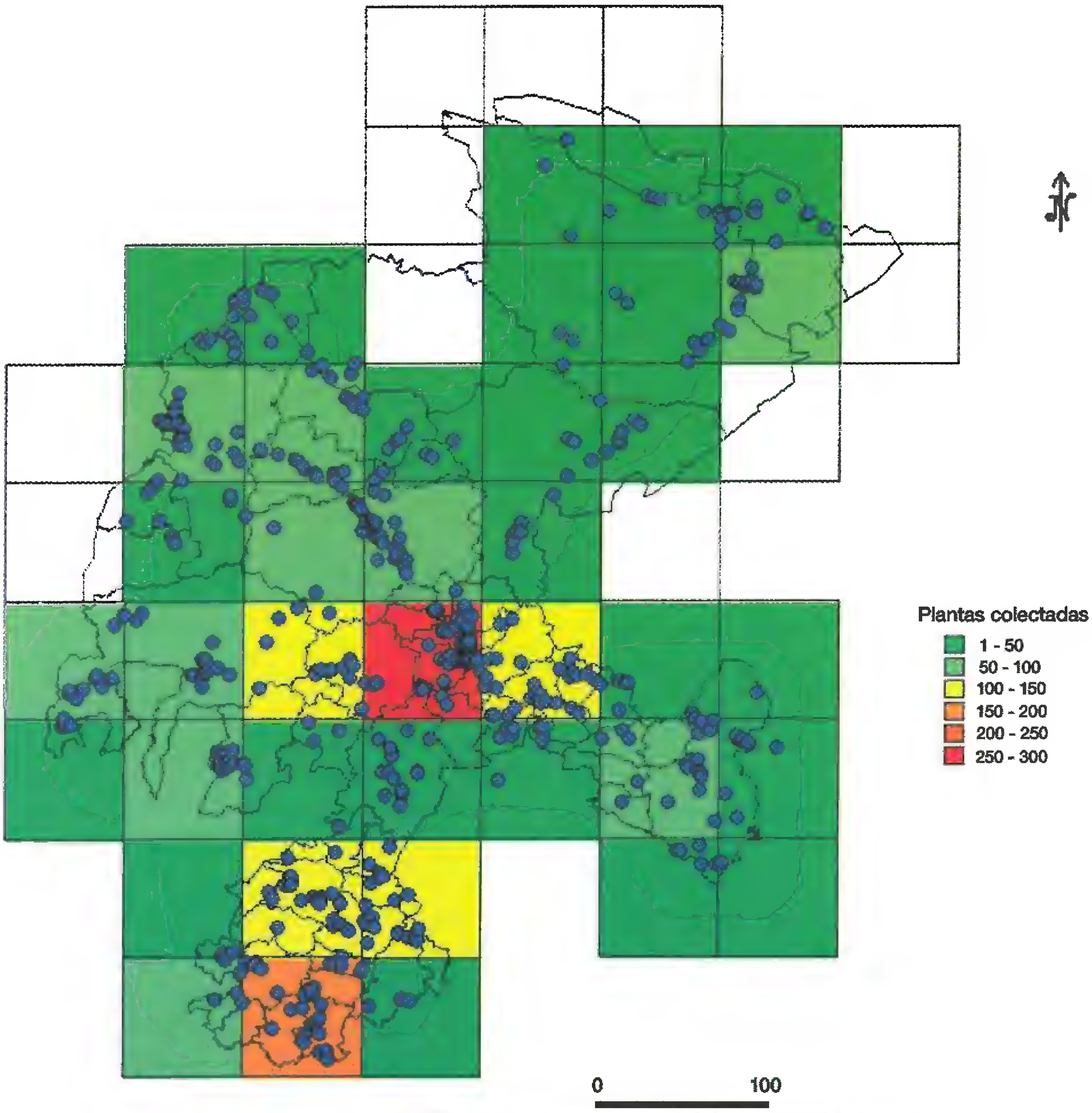


Fig. 2. Mapa representando el número (riqueza) de gramíneas colectadas en cada cuadro.

El resultado del análisis de intercambio fue un mapa que indica las celdas con mayor posibilidad de intercambio de especies (Fig. 5). En el mapa se aprecia que el valor de intercambio es mayor en la parte suroeste del estado, en donde se presenta mayor variación ambiental. Mientras que en la parte noreste presenta los valores de intercambio más bajos, debido a que la variación climática y del medio físico son relativamente más uniformes. Esta división coincide en términos generales con la distribución reportada por el INEGI: de la cubierta vegetal (2003), los rasgos climáticos (1980a), fisiográficos (1980b) y geológicos del estado (1980c).

En cuanto a la distribución altitudinal de las especies, la frecuencia es mayor en el intervalo altitudinal de 2020 a 2440 m, como puede verse en la gráfica de la Figura 8. Donde el 68% de las gramíneas prefieren este intervalo altitudinal.

Otras especies se favorecen por el sustrato donde se desarrollan (Tabla 1) como: I) especies adaptadas a suelos salinos, alcalinos o yesosos como *Aristida curvifolia, Bouteloua ramosa, Eragrostis obtusiflora, Erioneuron pilosum, Paspalum crinitum* y *Pleurhaphis mutica* encontradas en suelos alcalinos; *Bouteloua karwinskii, Distichlis spicata, Sporobolus airoides* y *S. pyramidatus* en suelos salinos y *Bouteloua chasei, B. karwinskii, B. ramosa,*

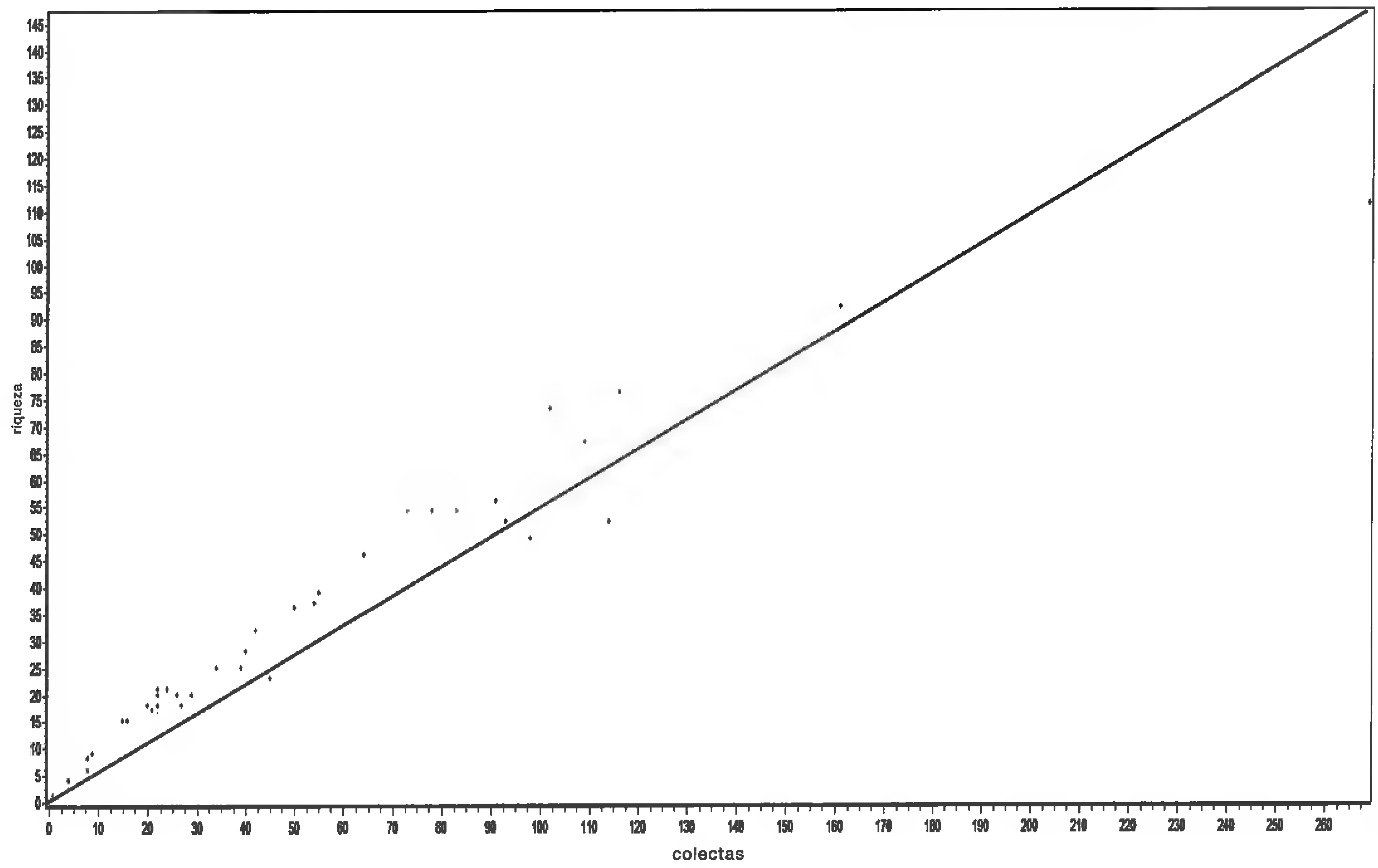


Fig. 3. Grafica de relación lineal entre número de colectas y diversidad (número de especies) de gramíneas.

Pleurhaphis mutica y *Sporobolus palmeri* encontrados en suelos yesosos. II) especies que requieren ambientes acuáticos ò subacuáticos para su crecimiento como *Chaboissaea ligulata, Distichlis spicata, Echinochloa colona, E. crusgalli, E. cruspavonis, E. holciformis, E. oplismenoides, Eragrostis obtusiflora, Eriochloa acuminata, Leersia hexandra, Leptochloa aquatica, L. fusca, Paspalum arsenei* y *P. denticulatum, P. distichum* que crecen en ambientes acuáticos. *Andropogon glomeratus, Guadua angustifolia, Panicum decolorans, P. elephantipes, Pappophorum vaginatum, Polypogon monspeliensis, Setaria adhaerens, Sporobolus pyramidatus* y *Urochloa texana* de ambientes subacuáticos y otras tantas tolerantes a vivir bajo el agua en alguna época como *Arundo donax, Chloris rufescens, Digitaria ternata, Eleusine indica, Leptochloa panicea, Muhlenbergia diversiglumis, M. polycaulis, M. rigens, Peyritschya deyeuxioides, P. pringlei, Polypogon elongatus, P. viridis, Tripsacum dactyloides* y *Urochloa plantaginea*.

DISCUSIÓN Y CONCLUSIONES

La familia Poaceae parece ser la segunda más diversa en el estado de Zacatecas, con sus 91 géneros, 284 especies y 40 infraespecies, es superada con mucho por la familia Asteraceae que cuenta en esta entidad con 141 géneros, 456 especies y 119 infraespecies (Balleza y Villaseñor 2005). Existe una distribución de los taxa de acuerdo a las características ecológicas del estado que concuerdan con lo encontrado y presentado por Balleza y Villaseñor (2005), aun con las mismas limitaciones muestrales existentes en ambos estudios.

Los tipos de cobertura vegetal que resultaron tener mayor diversidad de gramíneas son los bosques templados de encino-pino con 172 taxa (32%), le sigue el pastizal con 157 taxa (29.5%), el matorral con 139 taxa (26.1%) y el bosque tropical con sólo 64 (12%) (Tabla 1 y Fig. 7). Datos que coinciden con las proporciones de endemismos reportados por Rzedowski (1995) para la flora de diferentes tipos de vegetación de México. Comparando la riqueza relativa (Fig. 5) con el área cubierta por los tipos de vegetación (Fig. 6), puede notarse que los cuadros del noreste y este correspondientes al área de los matorrales de la región más árida del estado, son los menos diversos con 69 taxa (15%), donde los matorrales son comunidades de

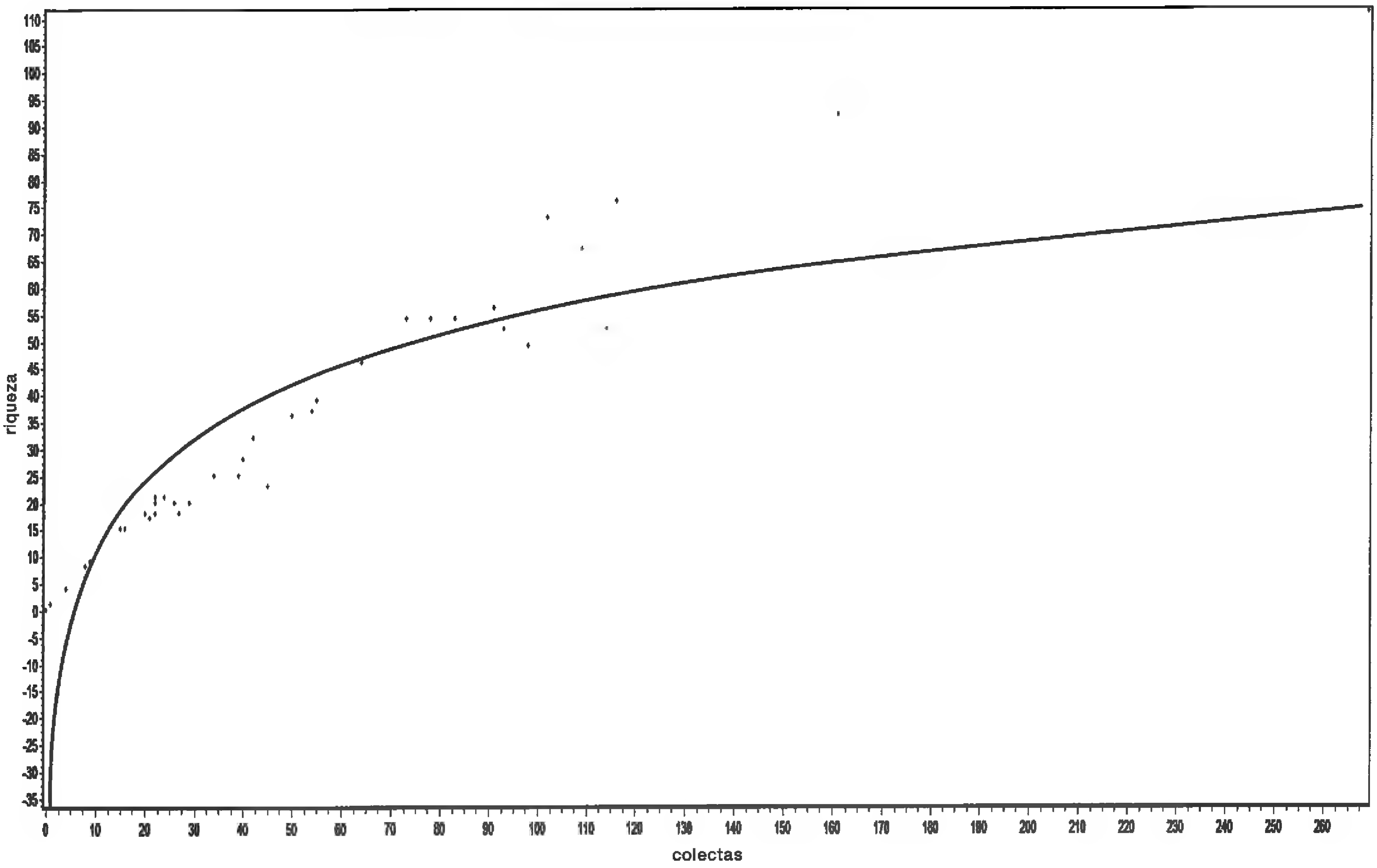


Fig. 4. Gráfica de regresión logarítmica entre número de colectas y diversidad de gramíneas del estado de Zacatecas.

tipo micrófilo y rosetófilo, en un gradiente altitudinal de 1640 a 2300 m. El área media del estado (cuadros naranja en Fig. 5) que corresponde a la región de pastizales, muchos de ellos ahora abiertos a la agricultura, con algo de bosque en la parte oeste y matorrales entreverados, presenta la diversidad más alta con 230 taxa (49%), con el gradiente altitudinal más moderado (1970 a 2440 m). Mientras que el área de los cuadros del suroeste (en rojo Fig. 5) se asocia a climas templados en las partes altas de la sierra, semiáridos en las partes medias y semicálidos en las partes bajas, tienen una riqueza media de 169 taxa (36%) en relación a los anteriores. Está región alberga los 4 tipos de vegetación aquí considerados de forma mezclada; bosques templados primordialmente de encino y encino-pino en las partes altas, pastizales y matorral xerófilo con elementos crasicaules y arbustos espinosos en las partes medias, y matorral subcaducifolio en las tierras bajas; en un gradiente altitudinal de 1100 a 2720 m.

Los 295 taxa (91 géneros y 284 especies 6 subespecies, 30 variedades y 4 formas en Anexo Tabla 1) encontrados en Zacatecas por Herrera et al. (2009), forman parte de 8 de las 10 subfamilias aceptadas para México por Dávila y col. (2006). La mayor diversidad se encuentra en la subfamilia Chloridoideae que resultó ser la mejor representada en Zacatecas con 125 taxa (42.37%) de la diversidad total, por ser este estado parte de la región de alta diversidad señalada para las Chloridoideae por Valdés y Cabral (1993). Esta subfamilia incluye en su haber a los 3 géneros con mayor número de taxa: *Muhlenbergia* (43), *Bouteloua* (25), *Eragrostis* (16), llegando a concentrar estos 3 géneros casi 1/3 de la diversidad de la familia (84 taxa = 28.47%). Le sigue en importancia la subfamilia Panicoideae con 93 taxa (31.52%) de la diversidad total, lo que se explica por la influencia que la Sierra Madre Oriental tiene sobre Zacatecas (Valdés y Cabral 1993). La subfamilia Pooideae le sigue con 53 taxa (17.97%) de la riqueza total. Las subfamilias Arundinoideae (2 taxa), Bambusoideae (3 taxa), Danthonioideae (1 taxa) y Ehrhartoideae (2 taxa), se encuentran poco representadas en la entidad, lo que se explica por ser subfamilias de origen y distribución en ecosistemas tropicales húmedos hasta ser especies acuáticas.

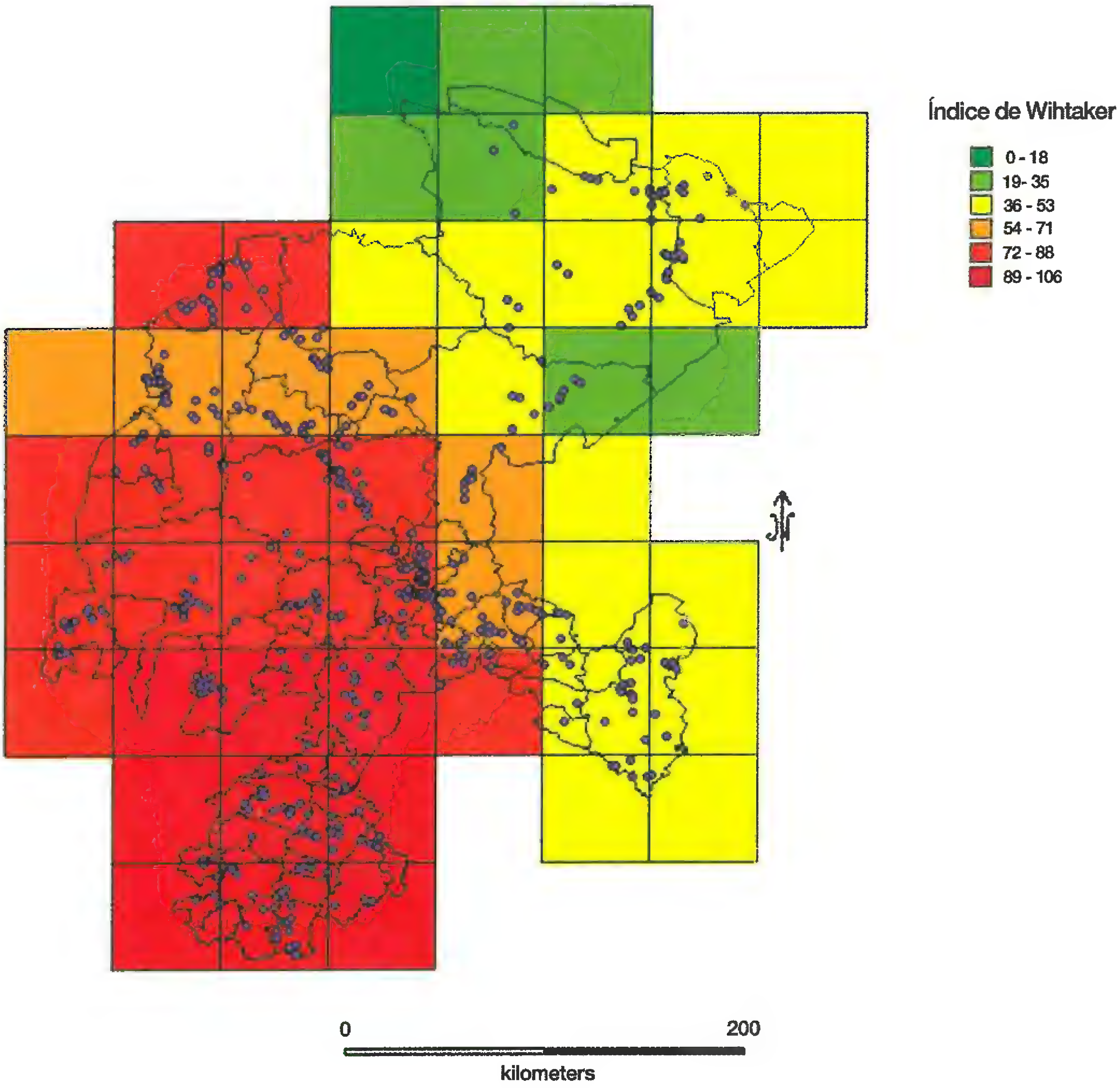


Fig. 5. Mapa con valores del índice de intercambio a nivel de celdas.

Por sus afinidades geográficas de las 284 especies de gramíneas de Zacatecas, 189 (66–5%) son nativas, 40 especies (14%) son introducidas (o exóticas) y 55 (19.5 %) son endémicas de México. De las gramíneas que son nativas de Zacatecas se encuentran 82 especies de afinidad Holártica (43.2%), 28 especies de afinidad Neotropical (15%) y 79 especies de toda América (41.8%), debido a la ubicación de esta entidad en la región donde converge la influencia de los reinos Holártico (en las provincias: Sierra Madre Occidental, Sierra Madre Oriental y Eje Neovolcánico) y Neotropical (en las provincias: Mesa Central y Sierra Madre Oriental). De particular importancia son las 55 especies presentes en Zacatecas que son endémicas de México (19.5%), de las cuales sólo 7 especies son endémicas de Zacatecas o de Zacatecas con algún estado vecino (2.48%): *Agrostis rosei, Blepharoneuron shepherdii, Bouteloua reederorum, Festuca roblensis, Muhlenbergia durangensis, M. flaviseta* y *M. pubigluma*. Dicho porcentaje de endemismos de Gramíneas en Zacatecas se aproxima, sin llegar al estimado por Rzedowski (1991) para esta familia en México (25%), o al 30% citado por Valdés y Cabral (1993). La calidad de los pastizales de Zacatecas para la producción pecuaria, se debe a que los taxa (especies e infraespecies) de gramíneas de esta región son por su origen principalmente de tipo nativo, y en escasa proporción exóticas como puede apreciarse en la Figura 9.

Tabla 1. Relación de gramíneas de Zacatecas con subfamilia, tipo de vegetación y origen.

	Formación vegetal					Origen			
Especie	Bos-Que	Selva	Mato-rral	Past-izal	Otros	Nativa	End-émica	Exótica	Sub-familia
Achnatherum editorum			x	x		M			Poo
Achnatherum eminens	x		x	x		Na			Poo
Achnatherum multimode	x					M			Poo
Aegopogon cenchroides	x					Sa			Chl
Aegopogon tenellus	x			x		Na			Chl
Agrostis hyemalis	x					A			Poo
Agrostis rosei	x						D,Z		Poo
Andropogon gerardii	x					A			Pan
Andropogon glomeratus var. pumilus			x		VS	A			Pan
Andropogon pringlei	x					M			Pan
Andropogon virginicus	x					Na			Pan
Aristida adscensionis	x	x	x	x		C			Ari
Aristida appressa	x			x		M			Ari
Aristida arizonica	x					Na			Ari
Aristida curvifolia			x	x	SA	M			Ari
Aristida divaricata	x	x	x	x		Na			Ari
Aristida havardii	x		x	x		Na			Ari
Aristida laxa var. laxa	x				x	Sa			Ari
Aristida pansa fo. dissita			MDM			Na			Ari
Aristida pansa fo. pansa			x	x		Na			Ari
Aristida purpurea var. nealleyi			x	x		Na			Ari
Aristida purpurea var. purpurea		x	x			Na			Ari
Aristida purpurea var. wrightii			x	x		Na			Ari
Aristida schiedeana var. schiedeana	x	x	x	x		Na			Ari
Aristida scribneriana	x		x	x		M			Ari
Aristida ternipes var. gentilis			x	x		Na			Ari
Aristida ternipes var. ternipes	x	x	x	x		A			Ari
Arundo donax fo. donax		x	x		VR, T			x	Aru
Arundo donax fo. versicolor		x	x		VR, T			x	Aru
Avena fatua				x	AC			x	Poo
Avena sativa					AC, AD			x	Poo
Blepharoneuron shepherdii	x						Ch,D,So,Z		Chl
Bothriochloa alta	x					Ca			Pan
Bothriochloa barbinodis	x		x	x		A			Pan
Bothriochloa hirtifolia	x			x		Ca			Pan
Bothriochloa hybrida			x	x		Na			Pan
Bothriochloa ischaemum			x					x	Pan
Bothriochloa laguroides var. torreyana			x	x	AC	Sa			Pan
Bothriochloa perforata	x		x	x		Na			Pan
Bothriochloa wrightii	x					Na			Pan
Bouteloua aristidoides			x	x		A			Chl
Bouteloua barbata var. barbata			x	x		A			Chl
Bouteloua chasei			MDM		SY	M			Chl
Bouteloua chondrosioides	x		x	x		Na			Chl
Bouteloua curtipendula var. caespitosa	x	x	x	x		Sa			Chl
Bouteloua curtipendula var. curtipendula			MDM	x	BG	Na			Chl

Tabla 1. continuación

	Formación vegetal					Origen			
Especie	Bos-Que	Selva	Mato-rral	Past-izal	Otros	Nativa	End-émica	Exótica	Sub-familia
Bouteloua curtipendula var. tenuis			MDM	x		M			Chl
Bouteloua dactyloides			x	x		Na			Chl
Bouteloua diversispicula		x		x		Ca			Chl
Bouteloua erecta		x				Na			Chl
Bouteloua eriopoda			x			Na			Chl
Bouteloua gracilis	x		x	x		Na			Chl
Bouteloua hirsuta var. glandulosa			x	x		Na			Chl
Bouteloua hirsuta var. hirsuta	x		x	x		Na			Chl
Bouteloua karwinskii			MDM	x	SH, SY	M			Chl
Bouteloua parryi var. parryi					BG	Na			Chl
Bouteloua polymorpha	x	x		x		M			Chl
Bouteloua radicosa	x	x		x		Na			Chl
Bouteloua ramosa			MDM		SA, SY	Na			Chl
Bouteloua reederorum			x	x			Ag,D,SL,Z		Chl
Bouteloua repens	x		x	x		Na			Chl
Bouteloua scorpioides	x		x	x		M			Chl
Bouteloua simplex	x		x	x		A			Chl
Bouteloua uniflora var. coahuilensis	x			x		M			Chl
Bouteloua williamsii	x	x		x		Ca			Chl
Brachypodium mexicanum	x		x	x		Sa			Poo
Bromus anomalus	x	x		x		Na			Poo
Bromus carinatus var. californicus	x		x	x		Na			Poo
Bromus catharticus var. catharticus				x	AD			Sa	Poo
Calamagrostis pringlei	x					M			Poo
Cenchrus brownii		x			AD			x	Pan
Cenchrus ciliaris		x	x		AD, VR			x	Pan
Cenchrus echinatus		x	x					x	Pan
Cenchrus incertus		x	x	x	AD	A			Pan
Cenchrus multiflorus		x				M			Pan
Cenchrus pilosus			MDM			Sa			Pan
Chaboissaea ligulata	x			x	VA	M			Chl
Chascolytrum subaristatum	x					Sa			Poo
Chloris gayana	x			x				x	Chl
Chloris rufescens	x	x			T	Ca			Chl
Chloris submutica	x		x	x	AD	A			Chl
Chloris virgata	x	x	x	x	AD, VR	C			Chl
Cortaderia selloana					Or	Sa			Dan
Cottea pappophoroides		x	x			A			Chl
Ctenium planifolium	x					M			Chl
Cynodon dactylon	x	x	x	x	VR			x	Chl
Dactyloctenium aegyptium		x						x	Chl
Dasyochloa pulchella			x	x	VR	Na			Chl
Dichanthelium sphaerocarpon	x					A			Pan
Digitaria califórnica var. californica		x	x	x	VR	Na			Pan
Digitaria ciliaris	x	x		x	VR	C			Pan
Digitaria cognata			MDM	x		Na			Pan

Tabla 1. continuación

Especie	Formación vegetal					Origen			Sub-familia
	Bos-Que	Selva	Mato-rral	Past-izal	Otros	Nativa	End-émica	Exótica	
Digitaria filiformis	x			x		Na			Pan
Digitaria panicea		x		x		M			Pan
Digitaria sanguinalis				x				x	Pan
Digitaria ternata	x			x	T			x	Pan
Distichlis spicata var. mexicana			x	x	SH, VA	A			Chl
Echinochloa colona		x	x	x	VA, VR			x	Pan
Echinochloa crusgalli var. crusgalli	x	x	x	x	VA, VR	A			Pan
Echinochloa crusgalli var. zelayensis	x	x	x	x	VA, VR	A			Pan
Echinochloa crus-pavonis var. crus-pavonis				x	VA	A			Pan
Echinochloa holciformis					VA, VR	Ca			Pan
Echinochloa jaliscana	x	x		x		M			Pan
Echinochloa oplismenoides	x		x	x	VA	Na			Pan
Eleusine indica	x	x		x	T			x	Chl
Eleusine multiflora	x							x	Chl
Elionurus barbiculmis	x		x	x		Na			Pan
Elionurus tripsacoides	x					Sa			Pan
Elymus arizonicus	x					Na			Poo
Elymus elymoides subsp. brevifolius	x					Na			Poo
Elymus repens subsp. repens	x				AD			x	Poo
Enneapogon desvauxii			x	x	VR	A			Chl
Enteropogon chlorideus		x			AD	Na			Chl
Eragrostis barrelieri			x		VR			x	Chl
Eragrostis cilianensis			x	x	VR			x	Chl
Eragrostis curvula				x				x	Chl
Eragrostis erosa			x			Na			Chl
Eragrostis hirta	x					Ca			Chl
Eragrostis intermedia var. appressa						Na			Chl
Eragrostis lehmanniana			x	x				x	Chl
Eragrostis lugens	x			x		A			Chl
Eragrostis mexicana subsp. mexicana	x	x	x	x	VR	A			Chl
Eragrostis obtusiflora			x	x	SA, VA	Na			Chl
Eragrostis palmeri	x		x	x		Na			Chl
Eragrostis pectinacea var. miserrima	x	x	x	x		A			Chl
Eragrostis pectinacea var. pectinacea	x	x	x	x		A			Chl
Eragrostis plumbea	x			x		M			Chl
Eragrostis pringlei						M			Chl
Eragrostis superba	x		x					x	Chl
Eriochloa acuminata var. acuminata		x	x	x	VR, VA	Na			Chl
Erioneuron avenaceum var. avenaceum		x	x			A			Chl
Erioneuron nealleyi				x		Na			Chl
Erioneuron pilosum			x		SA	A			Chl
Festuca arizonica	x					Na			Poo

Tabla 1. continuación

	Formación vegetal					Origen			
Especie	Bos-Que	Selva	Mato-rral	Past-izal	Otros	Nativa	End-émica	Exótica	Sub-familia
Festuca pringlei	x					M			Poo
Festuca roblensis	x						x		Poo
Festuca rosei	x					M			Poo
Gouinia virgata var. robusta		x				Sa			Chl
Guadua angustifolia	x	x			VS	Ca			Bam
Heteropogon contortus	x		x	x		A			Pan
Heteropogon melanocarpus			x	x		A			Pan
Hilaria cenchroides	x		x	x		Ca			Chl
Hilaria swallenii	x					Na			Chl
Hopia obtusa	x		x	x	VR	Na			Pan
Hordeum jubatum					AD	A			Poo
Hordeum vulgare					AC			x	Poo
Koeleria pyramidata	x					C			Poo
Lasiacis nigra		x				Sa			Pan
Leersia hexandra					VA, VR	Na			Ehr
Leptochloa aquatica					VA	M			Chl
Leptochloa dubia	x		x	x		A			Chl
Leptochloa fusca									
subsp. fascicularis			x		VA, VR	A			Chl
subsp. uninervia		x			VA	A			Chl
Leptochloa panicea subsp. brachiata				x	VR, T	A			Chl
Lolium multiflorum	x		x					x	Poo
Lolium perenne				x		A			Poo
Lolium temulentum					AD	A			Poo
Luziola fluitans				x	VA	NA			Ehr
Lycurus phalaroides	x		x	x		A			Chl
Lycurus phleoides	x		x	x		Na			Chl
Melinis repens	x	x	x	x				x	Pan
Metcalfia mexicana	x							x	Poo
Microchloa kunthii	x		x	x		A			Chl
Mnesithea granularis				x				x	Pan
Mnesithea ramosa					VR	SA			Pan
Muhlenbergia alamosae	x			x		M			Chl
Muhlenbergia arenacea	x		x	x		Na			Chl
Muhlenbergia arenicola			x	x		A			Chl
Muhlenbergia brevis	x					Na			Chl
Muhlenbergia brevivaginata	x					M			Chl
Muhlenbergia ciliata	x	x		x		Sa			Chl
Muhlenbergia crispiseta	x				BG	Na			Chl
Muhlenbergia depauperata	x			x		Na			Chl
Muhlenbergia diversiglumis	x			x	T	Sa			Chl
Muhlenbergia dubia	x					Na			Chl
Muhlenbergia dumosa			MDM			Na			Chl
Muhlenbergia durangensis	x						Ch,D		Chl
Muhlenbergia emersleyi	x		x	x	VR	Na			Chl
Muhlenbergia eriophylla	x					M			Chl
Muhlenbergia flaviseta	x			x			Ch,D		Chl
Muhlenbergia fragilis	x					Na			Chl
Muhlenbergia glauca	x					Na			Chl
Muhlenbergia implicata	x					Sa			Chl
Muhlenbergia longiglumis	x					M			Chl

Tabla 1. continuación

Especie	Formación vegetal					Origen			Subfamilia
	Bosque	Selva	Matorral	Pastizal	Otros	Nativa	Endémica	Exótica	
Muhlenbergia microsperma	x			x		A			Chl
Muhlenbergia minutissima	x	x				Na			Chl
Muhlenbergia montana	x					Na			Chl
Muhlenbergia mucronata	x					M			Chl
Muhlenbergia pectinata	x					Na			Chl
Muhlenbergia peruviana	x		x		BG	A			Chl
Muhlenbergia plumbea				x		Ca			Chl
Muhlenbergia polycaulis	x	x	x	x	VR, T	Na			Chl
Muhlenbergia porteri			x		VR	Na			Chl
Muhlenbergia pubescens	x		x	x		M			Chl
Muhlenbergia pubigluma	x		x	x			Co,NL,Z		Chl
Muhlenbergia quadridentata	x					M			Chl
Muhlenbergia repens	x					Na			Chl
Muhlenbergia rigens	x			x	VR, T	Na			Chl
Muhlenbergia rigida	x		x	x		A			Chl
Muhlenbergia robusta	x			x		Ca			Chl
Muhlenbergia scoparia	x					M			Chl
Muhlenbergia speciosa	x					M			Chl
Muhlenbergia stricta		x		x		M			Chl
Muhlenbergia tenuifolia	x	x	x	x	AD	A			Chl
Muhlenbergia texana	x			x		Na			Chl
Muhlenbergia utilis	x					Na			Chl
Muhlenbergia villiflora var. villiflora			x	x		M			Chl
Muhlenbergia virescens	x					Na			Chl
Nassella leucotricha	x					Na			Poo
Nassella mucronata	x					Sa			Poo
Nassella tenuissima	x					A			Poo
Oplismenus burmannii var. burmannii		x			BG	Sa			Pan
Otatea acuminata subsp. aztecorum		x	x			M			Bam
Panicum antidotale					AC			x	Pan
Panicum decolorans					VS, VR	M			Pan
Panicum elephantipes					VS, VR	A			Pan
Panicum hirticaule var. verrucosum			x	x		Na			Pan
Panicum lepidulum	x	x		x		Ca			Pan
Panicum vaseyanum	x					M			Pan
Panicum virgatum	x					Na			Pan
Pappophorum vaginatum			x		VS	A			Chl
Paspalum arsenei					VA	M			Pan
Paspalum convexum	x			x		Sa			Pan
Paspalum crinitum					SA, VS	M			Pan
Paspalum denticulatum					VA, VR	A			Pan
Paspalum distichum	x		x	x	VA	A			Pan
Paspalum humboldtianum	x			x		SA			Pan
Paspalum jaliscanum	x			x		CA			Pan
Paspalum notatum	x					A			Pan
Paspalum paniculatum		x				SA			Pan
Paspalum plicatulum	x	x		x		A			Pan
Paspalum tenellum	x			x		SA			Pan

Tabla 1. continuación

	Formación vegetal					Origen			
Especie	Bos-Que	Selva	Mato-rral	Past-izal	Otros	Nativa	End-émica	Exótica	Sub-familia
Pennisetum clandestinum					Or			x	Pan
Pennisteum crinitum	x		x	x		M			Pan
Pennisetum villosum	x		x	x				x	Pan
Pereilema ciliatum		x				Ca			Chl
Pereilema crinitum	x	x		x		Sa			Chl
Peyritschia deyeuxioides	x			x	VR, T	Sa			Poo
Peyritschia pringlei	x				VR, T	Sa			Poo
Phalaris canariensis			x					x	Poo
Phyllostachys aurea				x	AC			x	Bam
Piptochaetium fimbriatum	x	x		x		Na			Poo
Piptochaetium virescens var. virescens	x					Ca			Poo
Pleurhaphis mutica			MDM	x	SA, SY	Na			Chl
Poa annua	x		x	x		A			Poo
Poa strictiramea	x					Na			Poo
Polypogon elongatus	x		x		T	A			Poo
Polypogon monspeliensis			x		VS	A			Poo
Polypogon viridis	x		x		T	A			Poo
Saccharum officinarum						AC		x	Pan
Schedonorus arundinaceus						AC		x	Poo
Schizachyrium brevifolium	x			x		SA			Pan
Schizachyrium cirratum	x			x		A			Pan
Schizachyrium sanguineum	x		x	x	BG	A			Pan
Schizachyrium tenerum	x		x			A			Pan
Scleropogon brevifolius			x	x		A			Chl
Setaria adhaerens			x		VR, VS			x	Pan
Setaria grisebachii	x		x	x	VR	A			Pan
Setaria leucopila		x	x	x		A			Pan
Setaria macrostachya		x	x			A			Pan
Setaria parviflora	x	x	x	x	AD	A			Pan
Setariopsis auriculata		x	x			Sa			Pan
Setariopsis latiglumis		x				M			Pan
Sorghastrum incompletum	x	x		x		Sa			Pan
Sorghastrum nutans	x		x			A			Pan
Sorghum bicolor				x				x	Pan
Sorghum halepense	x		x	x				x	Pan
Sporobolus airoides var. airoides			x	PH		Na			Poo
Sporobolus atrovirens	x		x	x		M			Poo
Sporobolus cryptandrus			x			A			Poo
Sporobolus indicus var. indicus	x	x	x	x	VR	A			Poo
Sporobolus macrospermus			MDM			Ca			Poo
Sporobolus palmeri			x		SA, SY	M			Poo
Sporobolus pyramidatus			x	PH	SA, VR, VS	A			Poo
Sporobolus trichodes	x			x		M			Poo
Sporobolus wrightii			x	x	SA	Na			Poo
Steinchisma cuprea	x			x		M			Pan
Trachypogon spicatus	x		x	x		A			Pan
Tragus berteronianus			x	x	VR			x	Chl
Tridens muticus				x	VR	Na			Chl
Tripogon spicatus			x			A			Chl

Tabla 1. continuación

	Formación vegetal					Origen			
Especie	Bos-Que	Selva	Mato-rral	Past-izal	Otros	Nativa	End-émica	Exótica	Sub-familia
Tripsacum dactyloides var. dactyloides	x		x	x	T	Na			Pan
Tripsacum lanceolatum	x		x			Na			Pan
Tripsacum pilosum	x					Na			Pan
Tripsacum zopilotense	x					Ca			Pan
Trisetum viride	x			x		Ca			Poo
Triticum aestivum	x		x			C			Poo
Urochloa fusca			x	x	VR	A			Pan
Urochloa meziana	x					M			Pan
Urochloa panicoides			x	x				x	Pan
Urochloa plantaginea		x	x	x	T	A			Pan
Urochloa texana	x		x	x	VS	Na			Pan
Vulpia myuros var. hirsuta	x					Sa			Poo
Zea mays subsp. mays					AC	M			Pan
Zuloagaea bulbosa	x		x	x	BG	M			Pan

Por su origen nativas en: **A**= América*, **C**= Cosmopolita, **Ca**= Centroamérica**, **M**= México, **Na**= Norteamérica***, **Sa**= Sudamérica****

América*= distribución en todo el continente americano
Centroamérica**= distribución en México y Centroamérica
Norteamérica***= desde Canadá o Estados Unidos hasta México o hasta Centroamérica
Sudamérica****= desde México hasta Sudamérica

Endémicas en los Estados de: **Ag**= Aguascalientes, **Ch**= Chihuahua, **D**= Durango, **J**= Jalisco, **N**= Nayarit, **Mi**= Michoacán, **Si**= Sinaloa, **SLP**= San Luis Potosí, **So**= Sonora, **Z**= Zacatecas

Otros: **AC**= área de cultivo, **AD**= área de disturbio, **BG**= bosque de galería, **Or**= Ornamental, **PH**= pastizal halófilo, **SA**= suelos alcalinos, **SH**= suelos halófilos, **SY**= suelos yesosos, **VA**= vegetación acuática, **VR**= vegetación riparia, **VS**= vegetación subacuática, **T**= tolerante (subsiste en medios secos y acuosos por igual).

Subfamilias: **Ari**=Aristidoideae, **Aru**=Arundinoideae, **Bam**=Bambusoideae, **Chl**=Chloridoideae, **Dan**=Danthonioideae, **Ehr**=Ehrhartoideae, **Pan**=Panicoideae, **Poo**=Pooideae.

SUGERENCIAS

Los muestreos realizados con propósitos taxonómicos o florísticos se llevan a cabo tradicionalmente a lo largo de las principales vías de comunicación, lo que ocasiona que los estudios de biodiversidad con base en dichos muestreos, aplicando técnicas cuantitativas, arrojan resultados sesgados que dan pie a factibles malas interpretaciones. Sin embargo, los resultados del análisis de estos datos, aportan o contribuyen a una primera aproximación al conocimiento de la distribución y riqueza de especies (gramíneas en este caso), la cual podría mejorarse significativamente si el muestreo se realizara bajo un diseño apropiado para fines de conocer más objetivamente la distribución de riqueza o diversidad.

AGRADECIMIENTOS

Se reconoce y agradece el financiamiento recibido de la Comisión Nacional para el Uso y Manejo de la Biodiversidad (CONABIO-EE014), del CONACyT 53142 y del Instituto Politécnico Nacional (SIP-20060623 y SIP 20070429) al proyecto “Florística de las gramíneas de Zacatecas” y “Distribución y Diversidad de Gramíneas de Zacatecas” de los que se combinaron resultados para el análisis del presente trabajo. A las autoridades del CIIDIR IPN Unidad Durango, les agradecemos las facilidades recibidas para realizar las tareas que nos permitieron llevar a cabo y concluir el presente estudio. A los curadores de los herbarios consultados, se les agradece sus atenciones. Finalmente agradecemos las sugerencias de 2 revisores anónimos.

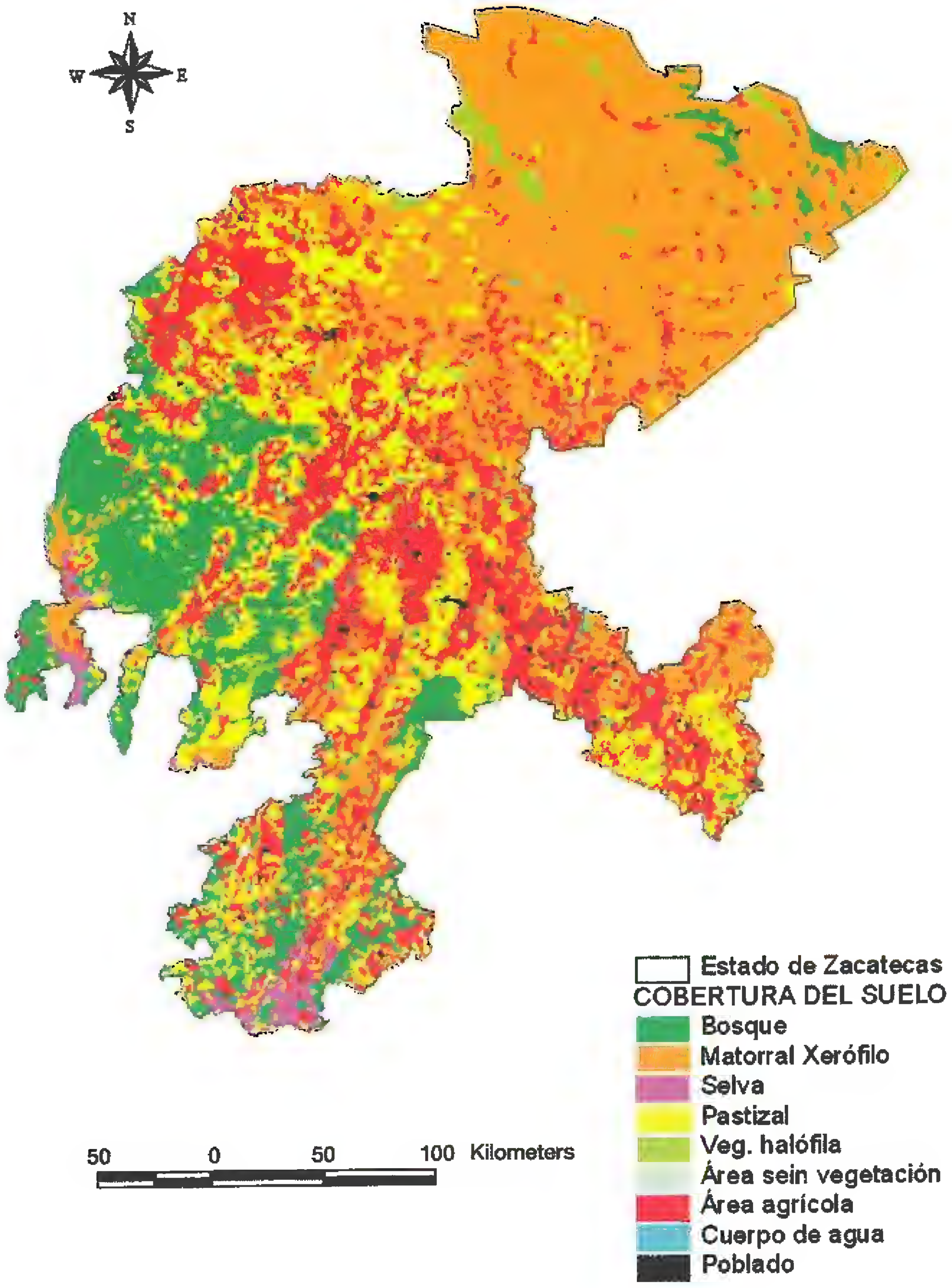

N
W
E
S
Estado de Zacatecas
COBERTURA DEL SUELO
Bosque
Matorral Xerófilo
Selva
Pastizal
Veg. halófila
Área sein vegetación
Área agrícola
Cuerpo de agua
Poblado
50
0
50
100 Kilometers

Fig. 6. Cobertura del suelo del estado de Zacatecas. Fuente: Conjunto de datos de Uso del suelo y Vegetación, escala 1:250 000 serie III (INEGI).

REFERENCIAS

Balleza C., J.J. y J.L. Villaseñor. 2005. Regionalización biogeográfica de Zacatecas, México, con base en los patrones de distribución de la familia Asteraceae. Rev. Mex. Biodivers. 76:71–78.

Challenger, A. 1998. Utilización y Conservación de los Ecosistemas Terrestres de México. Pasado, presente y futuro. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad; Instituto de Biología, Universidad Nacional Autónoma de México; y Agrupación Sierra Madre, S.C.

Clayton, W.D. y S.A. Renvoize. 1986. Genera graminum grasses of the World. Kew Bull. Addit. Ser. XIII. Royal Botanic Gardens, Kew.

Dávila, P., M.T. Mejía-Saulés, M. Gómez-Sánchez, J. Valdés-Reyna, J.J. Ortíz, C. Morín, J. Castrejón y A. Ocampo. 2006. Catálogo de las gramíneas de México. UNAM-CONABIO, México.

DeLong, D.C. Jr. 1996. Defining biodiversity. Wildlife Soc. Bull. 24:738–749.

Gaston, K.J. and J.I. Spicer. 2007. Biodiversidad introducción. Ed. Acribia, S.A., Zaragoza, España.

Herrera A., Y., P.M. Peterson y A. Cortés Ortiz. 2009. Gramíneas de Zacatecas, México. Sida, Bot. Misc.. In Press.

Hijmans, R.J., L. Guarino, C. Bussink, P. Mathur, M. Cruz, I. Barrantes, y E. Rojas. 2004. Diva-GIS versión 5, Sistema de información Geográfica para el análisis de Datos de Distribución de Especies. Manual. Internacional Plant Genetic Resources Institute (IPGRI) y UC Berkeley Museum of Vertebrate Zoology. http://www.diva-gis.org/Materials.htm

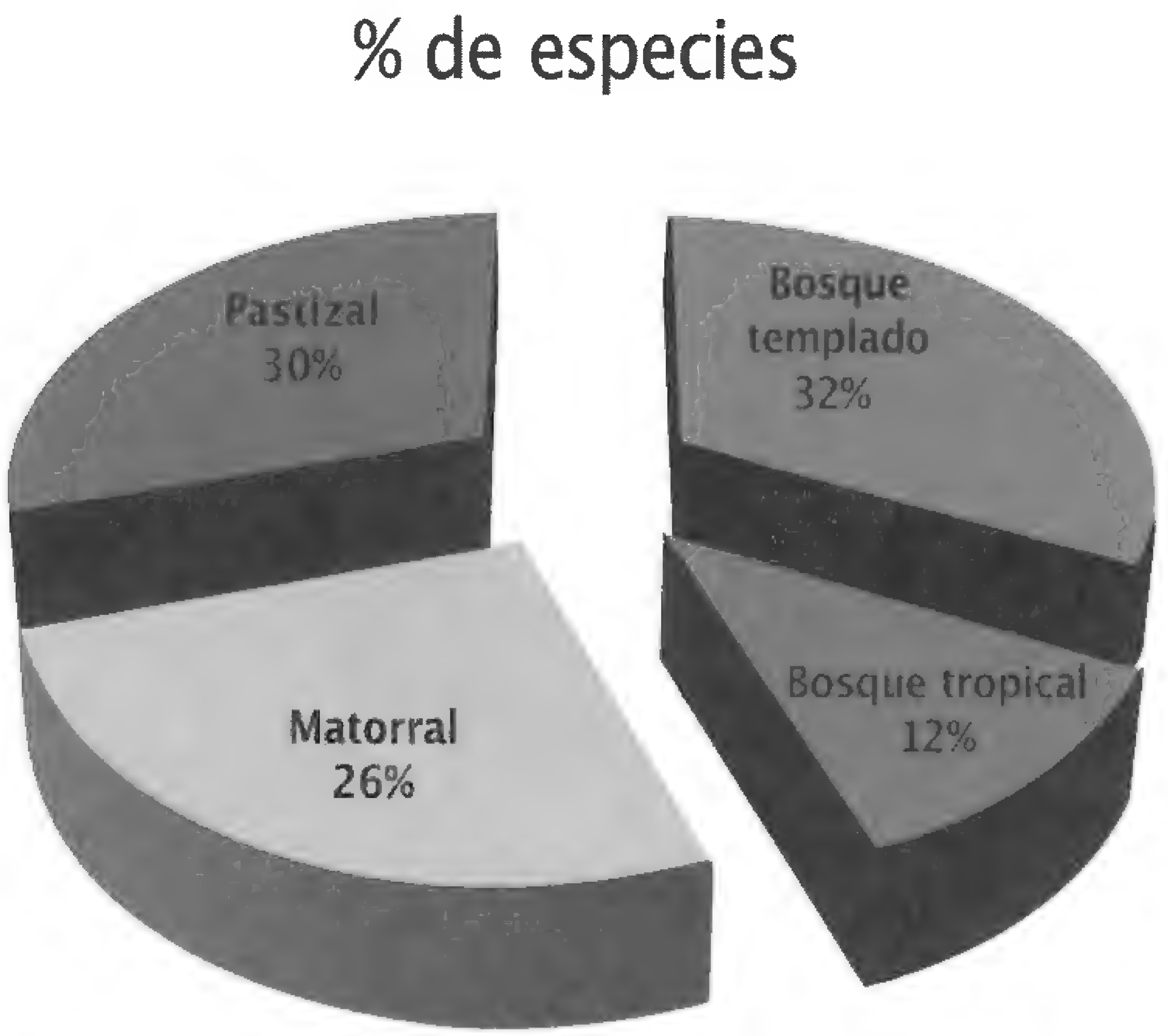


Fig. 7. Porcentaje de los principales tipos de vegetación en Zacatecas.

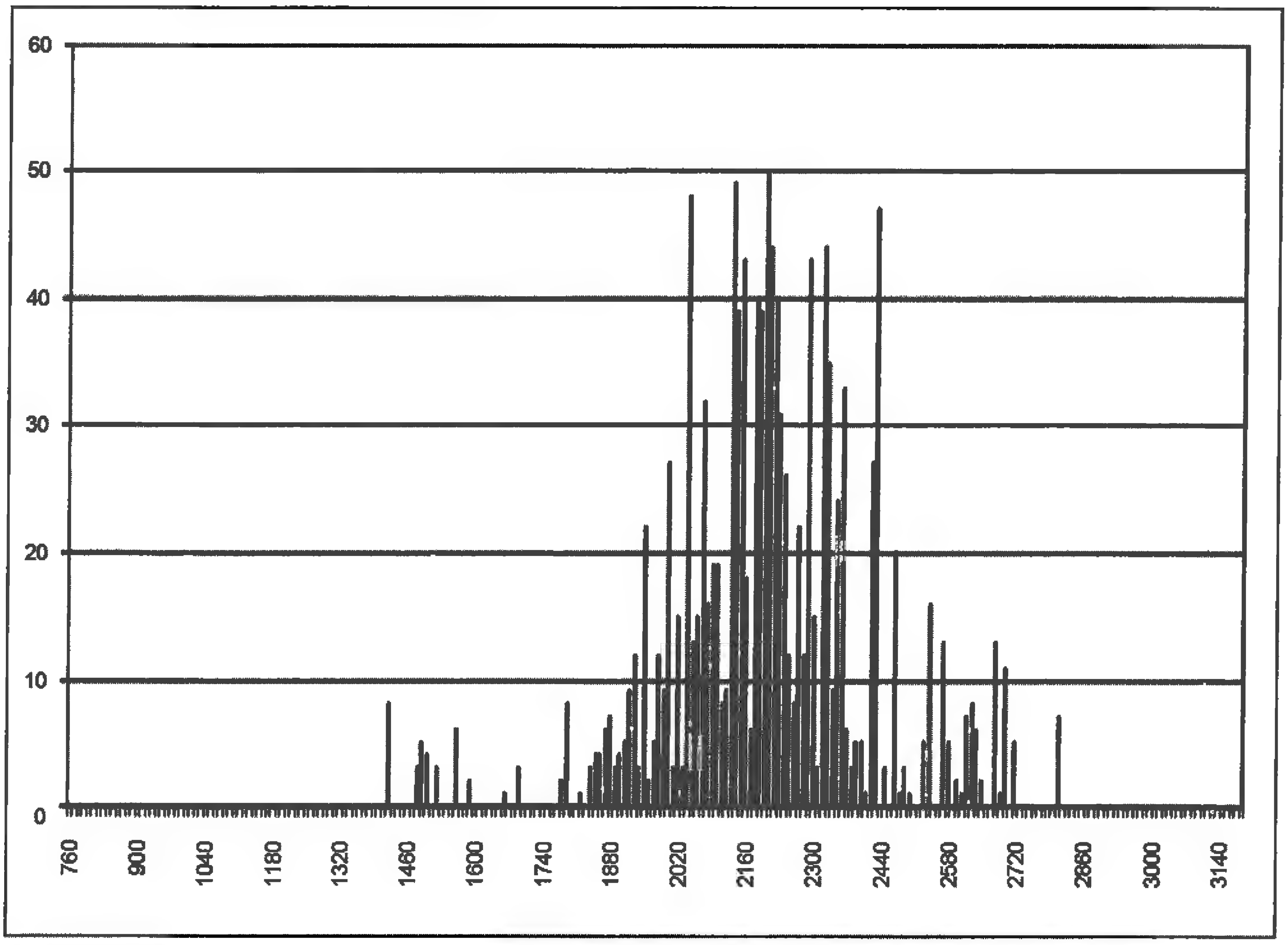


Fig. 8. Número de especies según la altitud.

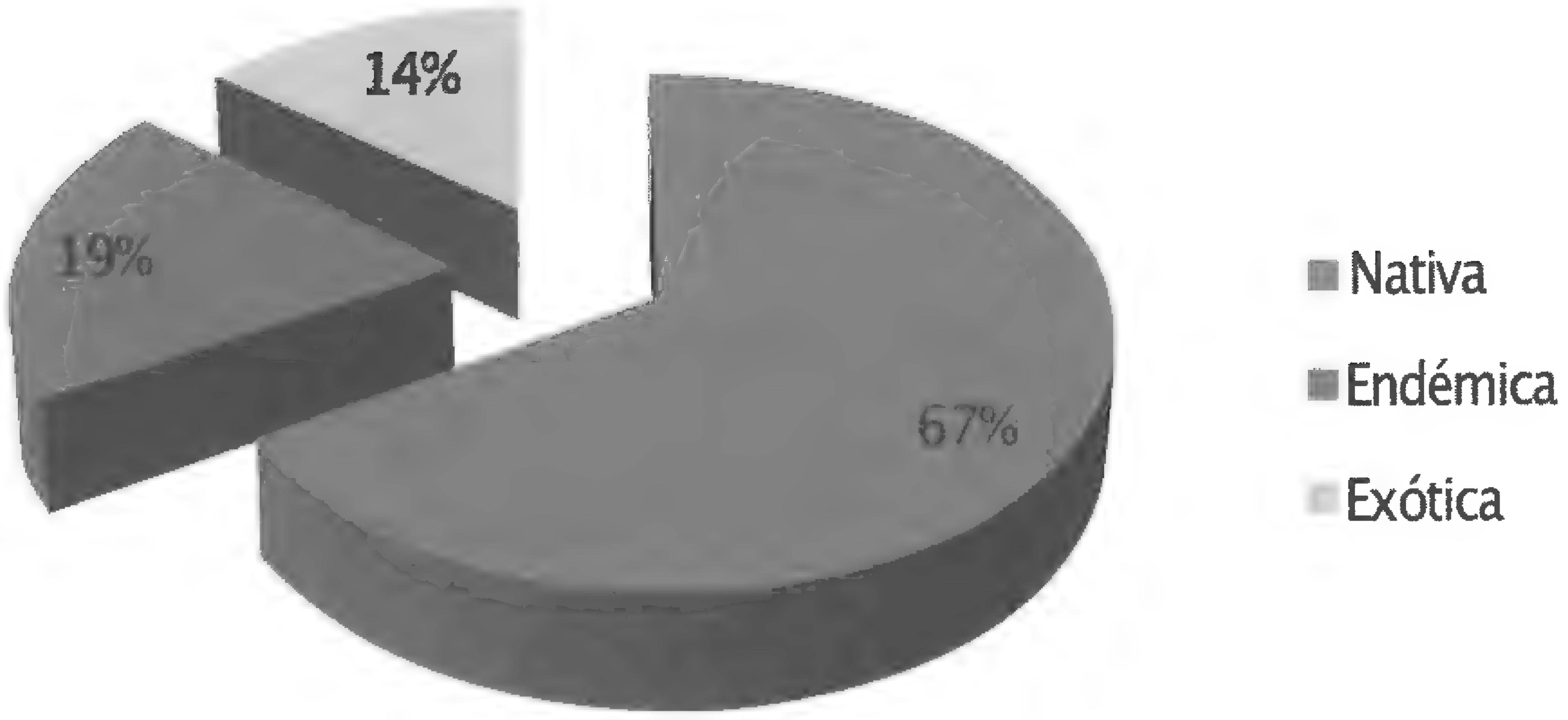


Fig. 9. Porcentaje de gramíneas en Zacatecas según su origen.

Hitchcock, A.S. 1951. Manual of the grasses of the United States. Ed. 2, revised by Agnes Chase. U.S. Dept. Agric. Washington, D.C.

Inegi. 1980a. Carta de climas, escala 1:1 000 000. Instituto Nacional de Estadística, Geografía e Informática, México.

Inegi. 1980b. Carta fisiográfica, Escala 1: 1 000 000. Instituto Nacional de Estadística, Geografía e Informática, México.

Inegi. 1980c. Carta geológica, Escala 1: 1 000 000. Instituto Nacional de Estadística, Geografía e Informática, México.

Inegi. 1996. Mapa digital Del Marco Geoestadístico 1995. Instituto Nacional de Estadística, Geografía e Informática, México.

Inegi. 1998a. Carta topográfica, escala 1: 250 000. f1303, f1305, f1306, f1309, f1404, f1409, g1309, g1312 y g1410. Instituto Nacional de Estadística, Geografía e Informática, México.

Inegi. 1998b. Diccionario de datos de uso del suelo y vegetación (vectorial), escala 1:1 000 000. Sistema Nacional de Información Geográfica. Instituto Nacional de Estadística, Geografía e Informática, México.

Inegi. 2003. Conjunto de datos de uso del suelo y vegetación serie II, escala 1: 250 000. f1303, f1305, f1306, f1309, f1404, f1409, g1309, g1312 y g1410. Instituto Nacional de Estadística, Geografía e Informática, México.

Inegi. 2006. Anuario Estadístico de zacate cas. Instituto Nacional de Estadística, Geografía e Informática, México.

Lawrence, H.M. 1951. Taxonomy of vascular plants. Macmillan Publishing Co., New York.

Nasa. 2000. http://www2.jpl.nasa.gov/srtm/. (consultado 15 Enero 2009)

Rzedowski, J. 1978. Vegetación de México. Limusa.

Rzedowski, J. 1991. El Endemismo en la Flora Fanerogámica Mexicana: una apreciación analítica preliminar. Acta Bot. Mex. 15:47–64.

Valdés Reyna, J. and I. Cabra Cabral. 1993. Chorology of Mexican grasses. In: Ramamoorthy, T.P., R Bye, A. Lot & J. Fa. Biological diversity of Mexico. Pp. 439–458.

LIPOCARPHA MICRANTHA (CYPERACEAE), NUEVA CITA PARA LA FLORA DE ARGENTINA: MICROMORFOLOGÍA DEL FRUTO

Priscila R. Van de Velde y M. Gabriela López

Instituto de Botánica del Nordeste
Sargento Cabral 2131
Corrientes 3400, ARGENTINA
pr.vandevelde@hotmail.com; mglopez@agr.unne.edu.ar

ABSTRACT

Lipocarpha micrantha (Vahl) G.C. Tucker (Cyperaceae) is recorded for the first time for the flora of Argentina and expands its distribution area in South America. It was previously known from Africa, North America (from the South of Canada), Central America and South America (from Venezuela and the Antilles, down to Paraguay and Uruguay). The new record from Corrientes, Argentina is based in a collection made in edges of water courses on sandy soils. A description and illustration of the species is provided, along with a study of the micromorphology of the fruits and a key for the identification of the two species in Argentina.

Key Words: *Lipocarpha micrantha*, new record, Argentinian flora, micromorphology of the fruit

RESUMEN

Lipocarpha micrantha (Vahl) G.C. Tucker (Cyperaceae) se cita por primera vez para la flora de Argentina y se amplia su área de distribución en América del Sur. Se la conocía previamente de África, América del Norte (desde el Sur de Canadá), América Central y América del Sur (desde Venezuela y las Antillas hasta Paraguay y Uruguay). La nueva especie de Corrientes, Argentina se basa en una colección hecha en bordes de cursos de agua con suelo arenoso. Se describe e ilustra y se acompaña con el estudio de la micromorfología de los frutos y una clave para la identificación de las dos especies en Argentina.

Palabras Clave: *Lipocarpha micrantha*, nueva cita, flora de Argentina, micromorfología del fruto

INTRODUCCIÓN

Lipocarpha R. Br. (Cyperaceae) pertenece a la subfamilia Cyperoideae, tribu Cypereae (Goetghebeur 1998) e incluye alrededor de 35 especies pantropicales (Goetghebeur & Van den Borre 1989) y de regiones templado cálidas. Son plantas anuales, rara vez perennes. Tallos ascendentes o curvados, glabros. Hojas generalmente más cortas que los tallos, aplanadas o rara vez algo revolutas, glabras. Inflorescencia en cabezuela terminal o pseudolateral, por la posición erguida de la bráctea involucral inferior, constituida por una o varias espigas ovoides o globosas; brácteas desiguales foliiformes, la inferior de mayor longitud, expandida o encerrando parcialmente la base de la inflorescencia. Espigas (20–)50–350+ floras, brácteas glumiformes, densamente dispuestas en espiral a lo largo de un eje, caedizas; cada una de ellas tectriz de una espiguilla uniflora, generalmente encerrada por un profilo adaxial y una gluma abaxial cubriendo al aquenio a la madurez. En algunas especies tanto el profilo como la gluma pueden estar en parte o totalmente reducidos. Perianto ausente; 1–3 estambres; estilo filiforme, 2–3 estigmas. Fruto obovoide o elipsoide de sección subtrígono, ligeramente aplanado dorsiventralmente o subterete, base sésil o estipitada; ápice con la base del estilo persistente, no engrosada; superficie finamente papilosa.

De Argentina se conocía solo *L. humboldtiana* Nees en las provincias de Chaco, Misiones, Entre Ríos y Corrientes (Barros 1947; Guaglianone 1996). En este trabajo se comunica la presencia de *L. micrantha* (Vahl) G.C. Tucker, encontrada en la provincia de Corrientes.

MATERIALES Y METODOS

Para la preparación de este trabajo se estudiaron ejemplares del Instituto de Botánica del Nordeste (CTES) y se realizaron observaciones de plantas vivas de *L. humboldtiana* y de *L. micrantha* a campo. Se extrajeron 10

J. Bot. Res. Inst. Texas 3(2): 793 – 798. 2009

frutos de cada ejemplar de herbario, a un grupo no se le realizó ningún tratamiento, al resto se les extrajo la pared periclinal externa (Schyuler 1971), por último los frutos se colocaron a centrífuga durante 5 min en 2 o más repeticiones (según necesidad), para realizar la remoción total de las impurezas. Se montaron en una platina de cobre y se metalizaron con oro paladio. Para su observación se utilizó el Microscopio Electrónico de Barrido (SEM), JOEL 5800 LV de La Universidad Nacional del Nordeste-Secretaría General de Ciencia y Técnica (UNNE-SECyT). La observación de los frutos se realizó a 15 kv y se tomaron fotografías digitales. La descripción de *L. micrantha* se basa en los materiales conocidos para Argentina.

RESULTADOS

Lipocarpha micrantha (Vahl) G.C. Tucker, J. Arnold Arbor. 68: 410.1987. (**Fig. 1**). *Scirpus micranthus* Vahl, Enum. Pl. 2:254. 1805. Tipo: *L.C. Richard s.n.* (holotipo: P!). *Hemicarpha micrantha* (Vahl) Pax in Engler & Prantl, Nat. Pflanzenfam. 2(2):105. 1888

Planta de 2–10 cm alt.; tallos 0.3–0.5 mm diám., densamente agrupados, rectos o curvados, cilíndricos, estriados. Hojas filiformes de 5–60 mm long. × 0.3–0.5 mm lat. Inflorescencia pseudolateral; brácteas involucrales 1–2(–3), la inferior siguiendo la dirección del tallo, las siguientes más cortas. Espigas compuestas 1–2(–3), ovoides o globosas, constituidas por brácteas glumiformes de 0.7–1 × 0.3–0.5 mm, densamente dispuestas en espiral, amarillas, rojizas en los bordes, 2 nervios marcados centrales desde la base hasta cerca del ápice, o sólo hasta a la mitad de su longitud, verdes; cada una tectriz de una espiguilla reducida a 1 flor. Raquis persistente, patente, cilíndrico, con cicatrices romboidales. Flores bisexuales. Estambres 1 (raro 2), anteras 0,2–0,4 mm, elipsoides, apiculadas, filamentos capilares. Estilo 0,2 mm long., filiforme, estigmas 2. Aquenio 0.5–0.7 mm long. × 0.2–0.3 mm lat., obovoide, sección subterete, cortamente apiculado, sésil, conspicuamente papiloso, amarillento o iridiscente, marrón claro cuando maduro.

Fenología.—Florece y fructifica todo el año (Kral 2001).

Ecología.—Se la encuentra en campos bajos temporalmente inundados, terrenos alterados, abiertos, bordes de ríos, suelos arenosos, pedregosos o turbosos; 0–1000 m.s.n.m.

Distribución geográfica (Fig. 2).—*Lipocarpha micrantha* es la única especie del género que habita en ambos hemisferios, en los continentes de África y América (Goetghebeur & Van den Borre 1989), en regiones tropicales y templadas. En América se distribuye desde el sur de Canadá en América del Norte hasta América del Sur llegando hasta Paraguay, Noreste de Argentina y Noreste de Uruguay. Su límite de distribución es 33° lat. Sur.

Material estudiado: **ARGENTINA. Corrientes. Dpto. Ituzaingó:** Rosario Cué, 15 km S de Ituzaingó, 23 May 1982, *R. Carnevalli* 5374 (CTES). **Dpto. Empedrado:** Camping de Empedrado, 14 Mar 2006, *M.G. López et al.* 385 (CTES). **Dpto. Capital:** Laguna Soto, Playa Bounganville, 10 Dic 2006, *M.G.López & R. O. Vanni* 386 (CTES).

CLAVE PARA SEPARAR LAS ESPECIES DE ARGENTINA

1. Hierbas con tallos de 2–10 cm long. Hojas con láminas filiformes de 0.3–0.5 mm lat. Inflorescencia seudolateral con 1–2(–3) espigas; espiguillas sin profilo; estigmas 2. Aquenio de 0,5–0,7 mm long. × 0,2–0,3 mm lat. **L. micrantha**
1. Hierbas con tallos de 30–90 cm long. Hojas con láminas no filiformes, redondeadas, acanaladas en el envés de 1 mm lat. Inflorescencia terminal con 3–5(–8) espigas; espiguillas con profilo; estigmas 3. Aquenio de 1–1,3 mm long. × 0,4–0,5 mm lat. **L. humboldtiana**

MICROMORFOLOGÍA DEL FRUTO

La ornamentación de los frutos tiene valor taxonómico en muchos de los géneros de Ciperáceas: Schuyler (1971) realizó el estudio de la superficie de los aquenios con MEB en los géneros *Scirpus* L. y *Eriophorum* L.; más tarde lo siguieron otros autores: Walter (1975), Toivonen & Timonen (1976), Standley (1987 y 1990) en el género *Carex* L.; Guaglianone (1979 y 1981) y Ragonese et al. (1984), en *Rhynchospora* Vahl; López & Matthei (1995) y Araújo & Longhi-Wagner (1997), en *Cyperus* L.; Goetghebeur & Coudijzer (1984) han publicado fotos de la superficie de frutos de las especies de *Bulbostylis* de África Central; López (2006, 2007)

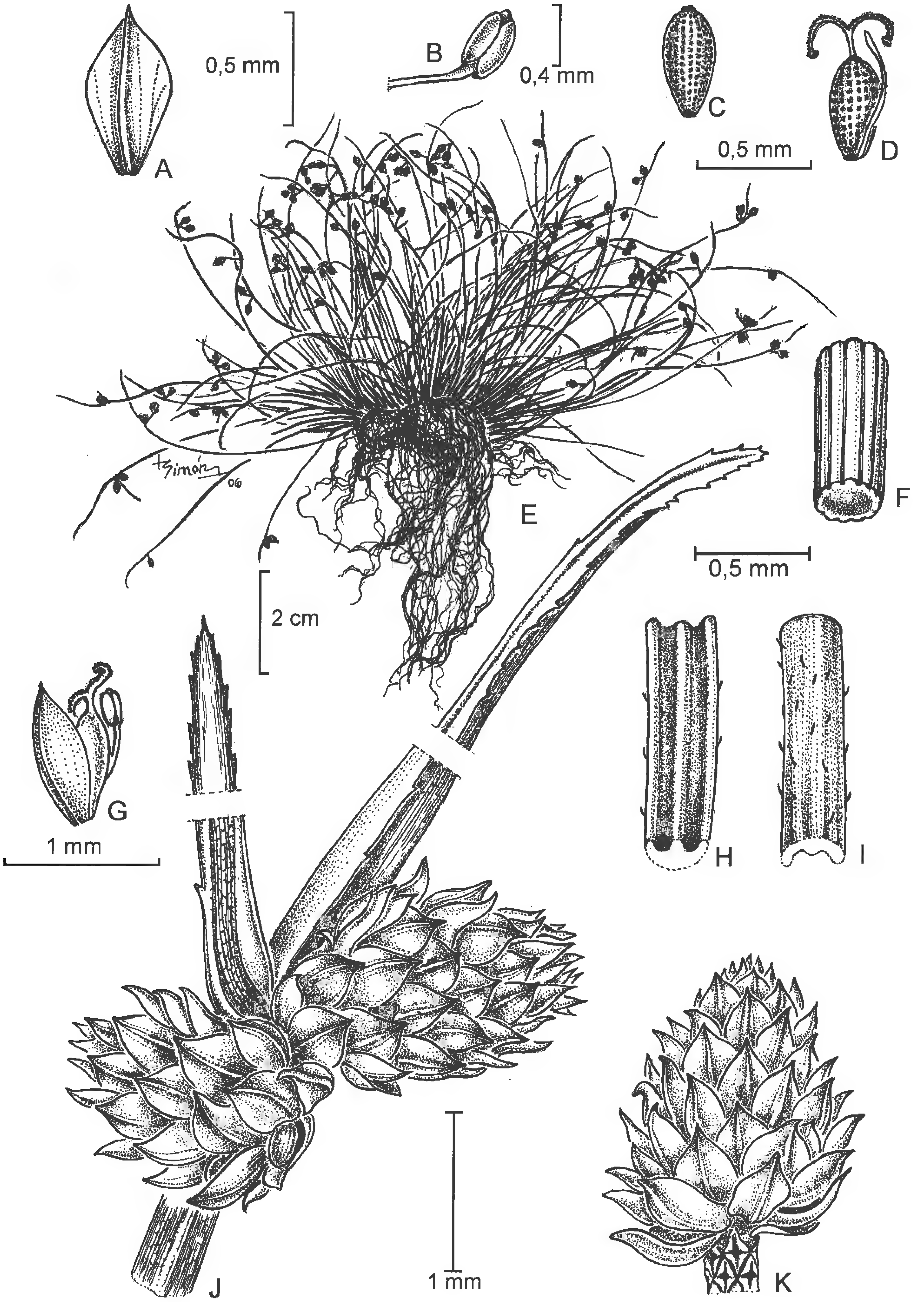

A
0,5 mm
B
0,4 mm
C
0,5 mm
D
E
Simón 06
F
0,5 mm
2 cm
G
1 mm
H
I
J
1 mm
K

Fig. 1. *Lipocarpha micrantha*. A. Bráctea, vista dorsal. B. Estambre. C. Fruto. D. Fruto con rudimentos de estilo y estambre. E. Planta. F. Porción de tallo. G. Espiguilla reducida a 1 flor, en la axila de la bráctea. H–I. Porción de la bráctea de la inflorescencia; H. cara adaxial, I. cara abaxial. J. Inflorescencia. K. Espiga. (A, C–F, H–K de *López et al. 385*. B, G de *López et al. 386*).

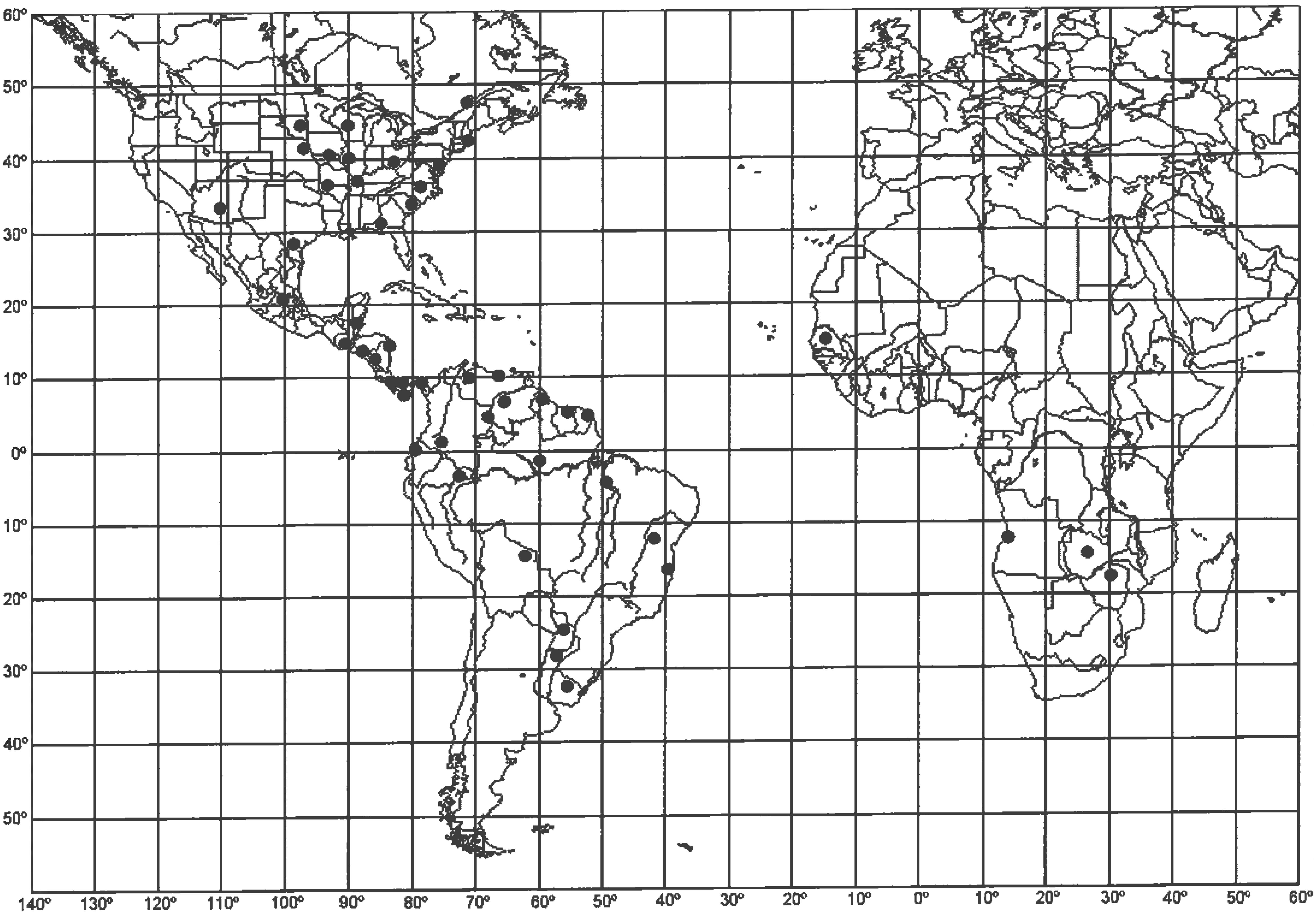


Fig. 2. Distribución geográfica de *Lipocarpha micrantha* en América y Africa.

y López et al. (2007) en algunas especies de *Bulbostylis* de Sudamérica. Lye (2000) estudió detalladamente con MEB los frutos de alrededor de 600 especies de Cyperáceas de todos los continentes Goetghebeur & Van den Borre (1989) realizaron el estudio de 16 especies de las 35 del género haciendo referencia a la falta de datos suficientes sobre la variabilidad intraespecífica. Entre las especies estudiadas no incluyeron a *L. micrantha*.

En *L. micrantha* se distinguen en vista superficial células en su mayoría hexagonales y algunas pentagonales con protuberancias centrales, redondeadas (Fig. 3; D, E); Al remover la pared periclinal externa del exocarpo, se observa que la pared anticlinal es muy levemente ondulada y delgada, la plataforma basal es cóncava y lisa. En frutos no maduros el cuerpo central en el ápice es peltado, liso, con una leve concavidad y ondulaciones en su extremo distal (Fig. 3; F, G). En frutos maduros el cuerpo central es cónico, con proyecciones apicales irregularmente ramificadas, con características similares a las de *Cyperus reflexus* Vahl var. *reflexus* (López & Matthei 1995), (Fig. 3; J). La cara inferior de la plataforma de los cuerpos de sílice, es ligeramente excavada y cubierta por pequeñas incrustaciones silíceas en toda la superficie (Fig. 3; H, I).

En los frutos de *L. humboldtiana* en vista superficial no se puede definir la forma de las células ya que el límite es oscuro y se observan protuberancias truncadas (Fig. 3; A, B). Sin la pared periclinal externa las células son hexagonales, la pared anticlinal es recta y delgada, la plataforma basal es convexa y lisa, el cuerpo central cilíndrico, truncado, sin ondulaciones y plano (Fig. 3, C).

AGRADECIMIENTOS

Expresamos nuestro profundo agradecimiento a la Prof. Rosa Guaglianone por las sugerencias brindadas; a la Sra. Laura Simón por la realización de la lámina, Srita. Valeria Mambrín por su colaboración en la acetólisis de los frutos y Lic. Cristina Salgado por su atención en el MEB.

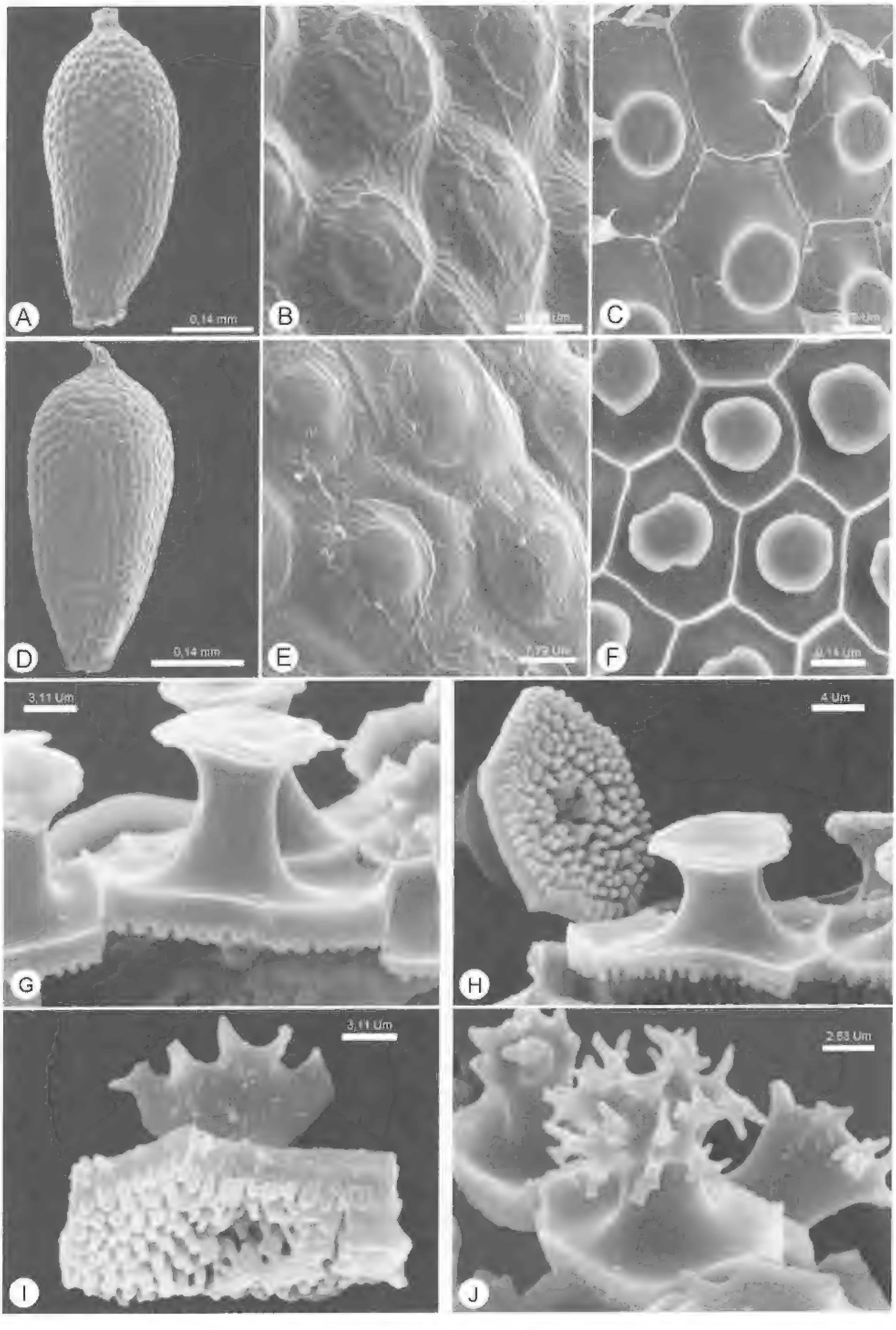


Fig. 3. Microfotografías con MEB de aquenios de *Lipocarpha* R.: *L. humboldtiana* (A–C): **A.** Fruto. **B.** Vista superficial de la pared periclinal externa. **C.** Detalle de la pared periclinal interna, mostrando los cuerpos de silicio; *L. micrantha* (D–J): **D.** Fruto. **E.** Vista superficial de la pared periclinal externa. **F.** Detalle de la pared periclinal interna, mostrando los cuerpos de silicio. **G–J.** Cuerpos de silicio. **G.** Cuerpo central. **H.** Vista inferior de plataforma basal. **I.** Vista inferior de la plataforma basal en fruto maduro. **J.** Detalle de cuerpo central cónico con ramificaciones apicales. (A–C de *Ahumada 2139*. F–H de *López et al 385*. I, J de *R. Carnevalli 5374*).

REFERENCIAS

Araújo, A.C. and H.M. Longhi-Wagner. 1997. Anatomia foliar e micromofologia do fruto na taxonomia de *Cyperus* L. (Cyperaceae). Iheringia, Bot. 48:103–120.

Barros, M. 1947. Cyperaceae - Scirpoideae. En: H. Descole, ed. Gen. et Sp. Pl. Argent. 4(1):9–13.

Goetghebeur, P. and J. Coudijzer. 1984. Studies in Cyperaceae 3. *Fimbristylis* and *Abildgaardia* in Central Africa. Bull. Jard. Bot. Belg. 54:65–89.

Goetghebeur, P. and A. Van den Borre. 1989. Studies in Cyperaceae. 8. A revision of *Lipocarpha*, including *Hemicarpha* and *Rikliella*. Wageninger Agric. Univ. Pap. 89:1–87.

Goetghebeur, P. 1998. Cyperaceae. En: K. Kubitzki y collaborators, eds. The families and genera of vascular plants 4:141–190.

Guaglianone, E.R. 1979. Sobre *Rhynchospora rugosa* (Vahl) Gale (Cyperaceae) y algunas especies afines. Darwiniana 22:255–311.

Guaglianone, E.R. 1981. Contribución al estudio del género Rhynchospora Vahl (Cyperaceae) III. Darwiniana 23:489–506.

Guaglianone, E.R. 1996. Cyperaceae. *En:* Zuloaga F. and O. Morrone, eds. Catálogo de las plantas vasculares de la República Argentina I. Monogr. Syst. Bot., Missouri Bot. Gard. 60:175.

Kral, R. 2001. *Lipocarpha* (Cyperaceae). En: Stevens, W. D., C. Ulloa Ulloa, A. Pool, O. M. Montiel, A. L. Arbeláez, and D. M. Cutaia, eds. eds. Flora de Nicaragua (Tomo I) Monogr. Syst. Bot., Missouri Bot. Gard. 85:773–774.

López, M.G. 2006. Nuevas citas de *Bulbostylis* (Cyperaceae) para las floras de Bolivia y Paraguay. Bonplandia 15(3–4):149–160.

López, M.G. 2007. Tres Nuevas Especies en el Género *Bulbostylis* (Cyperaceae) de Sudamérica. Novon 17: 497–502.

López, M.G., A.P. Prata, and W.W. Thomas. 2007. New synonymy and new distributional records in *Bulbostylis* (Cyperaceae) from South America. Brittonia 59:88–96.

López, P.S. and O.J. Matthei. 1995. Micromorfología del Aquenio en especies del género Cyperus L. (Cyperaceae), Chile. Gayana Bot. 52:67–75.

Lye, K. 2000. Achene structure and function of structure in Cyperaceae. En: Wilson K. L. and D.A. Morrison, eds. Monocots: systematics and evolution. CSIRO, Melbourne. Pp. 615–628.

Ragonese A.M., E.R. Guaglianone, and C. Dizeo de Strittmatter. 1984. Desarrollo del pericarpio con cuerpos de sílice de dos especies de *Rhynchospora* Vahl (Cyperaceae). Darwiniana 25:27–41.

Schuyler, A. 1971. Scanning electron microscopy of achene epidermis in species of Scirpeae and related genera. Proc. Acad. Nat. Sci. Philadelphia. 123:29–52.

Standley, L. 1987. Anatomical studies of *Carex cuchumatensis*, *C. decidua*, and *C. hermanii* (Cyperaceae) and comparisons with North American taxa of the *C. acuta* complex. Brittonia 39:11–19.

Standley, L.1990. Anatomical aspects of the taxonomy of sedges (*Carex*,Cyperaceae). Canad. J. Bot. 68: 1449–1456.

Toivonen, H. and T. Timonen. 1976. Perigynium and achene epidermis in some species of *Carex*, subg. *Vignea* (Cyperaceae) studied by scaning electron microscopy. Ann. Bot. Fenn. 13:49–59.

Walter, K.S. 1975. A preliminary study of the achene epidermis of certain *Carex* (Cyperaceae), using scaning electron microscopy. Michigan Bot. 14:67–72.

CHECKLIST OF THE PLANTS OF THE GUIANA SHIELD
1. AN UPDATE TO THE ANGIOSPERMS

Christian Feuillet

Department of Botany, MRC-166
Smithsonian Institution
P.O. Box 37012
Washington, D.C. 20013-7012, U.S.A.
feuillec@si.edu

ABSTRACT

An update to the *Checklist of the Plants of the Guiana Shield* is proposed. It comprises more than 700 additions, corrections, and synonymies for the Angiosperms. Two new combinations are made in the Rubiaceae: **Appunia longipedunculata** and **Appunia peduncularis.**

RÉSUMÉ

Une mise à jour de la *Checklist of the Plants of the Guiana Shield* est offerte. Elle comprend plus de 700 additions, corrections et synonymies pour les Angiospermes. Deux combinaisons nouvelles sont faites dans les Rubiaceae: **Appunia longipedunculata** et **Appunia peduncularis.**

The flora of the Guiana Shield is the object of strong interest that fostered various international programs as evidenced and enhanced by the publication of the *Flora of the Guianas* (Görts-van Rijn & Janssen-Jacobs 1985–present; in progress), the *Flora of the Venezuelan Guayana* (Berry et al. 1995–2005), and the *Guide to the vascular plants of central French Guiana* (Mori et al. 1997 and 2002), as well as by the large specimen-based database at the Department of Botany of the Smithsonian Institution. There was a need to compare results and therefore for conformity of the taxonomy. The *Checklist of the Plants of the Guiana Shield* (Funk et al. 2007) was the tool to fill that need. The phase of data gathering for the *Checklist* was completed in 2005. Since then, many papers have been published on the flora of the region adding several species, changing their generic placement, or refuting their presence in the Guiana Shield. Furthermore, due to the widely scattered literature, some taxa were overlooked. Hence many additions, deletions, and corrections must be made before an updated version of the *Checklist* can be offered for consultation on-line. This paper presents 719 modifications needed for the Angiosperms and gathers in one place the references for the new species. The results are presented in the Appendix. For the Angiosperms, 211 names are added to the checklist and 159 are placed in synonymy or rejected. Therefore, there is a gain of 52 and the total number of accepted subgeneric names is now 14,784.

A later paper will update the ferns and allied groups. The Checklist (Funk et al. 2007) can be downloaded from http://botany.si.edu/bdg/plants.html along with this update and relevant pdf files.

If you know of taxa that should have been added, edited, or deleted, please let me know.

APPENDIX: MODIFICATIONS

The families are presented in alphabetical order under the family name used in the *Checklist* (Funk et al. 2007). The names of the families are followed by the pages where they can be found in the *Checklist*. Names of species and infraspecific taxa to be added are in **bold**, followed by the symbols of the regions (**AM** = Amazonas; **BO** = Bolivar; **DA** = Delta Amacuro; **FG** = French Guiana; **GU** = Guyana; **SU** = Surinam). Names of species in *italics* are to be edited or deleted. As in the checklist, the family chapters are followed when needed by two paragraphs: "Synonyms and misidentifications" and "References." Occasionally a note clarifies a problem.

Reference (p. 15–16)

Add: Clark, H., R. Liesner, P.E. Berry, A. Fernández, G. Aymard, and P. Maquirino. 2000. Catálogo anotado de la flora del área de San Carlos de Río Negro, Venezuela. Sci. Guaianae 11:101–333 + 21 color photos.

J. Bot. Res. Inst. Texas 3(2): 799 – 814. 2009

ANTHOPHYTA: MONOCOTYLEDONAE

ARACEAE (p. 59–67)

Monstera barrieri Croat, Moonen & Poncy—**FG**
Philodendron scottmorianum Croat & Moonen—**FG**

References

Croat, T.B. and J. Moonen. 2007. *Philodendron scottmorianum*, a new species of *P.* sect. *Philodendron* (Araceae) from the Guianas. Willdenowia 37:535–539.

Croat, T.B., J. Moonen, and O. Poncy. 2005. New species of *Monstera* (Araceae) from French Guiana. Rodriguésia 56(88):61–64.

ARECACEAE (p. 67–73)

Bactris nancibaensis J.J. de Granville—**FG**

Reference

Granville, J.-J. de. 2007. A new species of *Bactris* (Palmae) from French Guiana. Brittonia 59:354–356.

BROMELIACEAE (p. 73–83)

Pitcairnia cremersii Gouda—**SU, FG**
Pitcairnia incarnata Baker—should be deleted
Pitcairnia leprieurii Baker—should be deleted
Pitcairnia rubiginosa Baker—correct author—add **GU**
Pitcairnia rubiginosa var. *amazonica* (Baker) L.B. Sm.—correct spelling of species epithet
Pitcairnia rubignosa (Baker) Mez—should be deleted
Pitcairnia saxosa Gouda—**FG**
Pitcairnia semijuncta Baker—**GU, SU, FG**

Synonyms and misidentifications

Hepetis amazonica (Baker) Mez—should read "=*Pitcairnia rubiginosa* var. *amazonica* (Baker) L.B. Sm."
Pepinia incarnata (Baker) G.S. Varad. & Gilmartin = *Pitcairnia caricifolia* Mart. ex Schult. f.
Pitcairnia amazonica Baker—should read "=*Pitcairnia rubiginosa* var. *amazonica* (Baker) L.B. Sm."
Pitcairnia incarnata Baker = *Pitcairnia caricifolia* Mart. ex Schult. f.
Pitcairnia leprieurii Baker = *Pitcairnia rubiginosa* Baker

Reference

Gouda, E.J. 2009. Studies on the flora of the Guianas: the genus *Pitcairnia* (Bromeliaceae). Selbyana 30:80–88.

COSTACEAE (p. 86–87)

Chamaecostus congestiflorus (Rich. ex L.F. Gagnep.) C. Specht & D.W. Stev.—**DA, GU, SU, FG**
Chamaecostus curcumoides (Maas) C. Specht & D.W. Stev.—**FG**
Chamaecostus lanceolatus (Petersen) C. Specht & D.W. Stev.—**SU, FG**
Chamaecostus lanceolatus subsp. **pulchriflorus** (Ducke) C. Specht & D.W. Stev.—**SU, FG**
Costus congestiflorus Rich. ex L.F. Gagnep.—should be deleted
Costus curcumoides Maas—should be deleted
Costus lanceolatus Petersen—should be deleted
Costus lanceolatus subsp. *pulchriflorus* (Ducke) Maas—should be deleted

Synonyms and misidentifications

Costus congestiflorus Rich. ex L.F. Gagnep. = *Chamaecostus congestiflorus* (Rich. ex L.F. Gagnep.) C. Specht & D.W. Stev.
Costus curcumoides Maas = *Chamaecostus curcumoides* (Maas) C. Specht & D.W. Stev.
Costus lanceolatus Petersen = *Chamaecostus lanceolatus* (Petersen) C. Specht & D.W. Stev.
Costus lanceolatus subsp. *pulchriflorus* (Ducke) Maas = *Chamaecostus lanceolatus* subsp. *pulchriflorus* (Ducke) C. Specht & D.W. Stev.

Reference

Specht, C. and D.W. Stevenson. 2006. A new phylogeny-based generic classification of Costaceae (Zingiberales). Taxon 55:153–163.

CYPERACEAE (p. 88–103)

Bulbostylis medusae Prata, Reynders & Goetgh.—edit author and delete "sp. nov. ined."

Reference

Prata, A.P., K. Camelbeke, M. Reynders, I.C. Fedón, P. Goetghebeur, and O. Huber. 2007. *Bulbostylis medusae* (Cyperaceae), a new species from Venezuela. Novon 17:67–71.

ORCHIDACEAE (p. 118–149)

Habenaria armata Rchb. f.—add **SU**
Habenaria ayangannensis Renz—delete comment in the square brackets—add **BO**
Habenaria hamata Barb. Rodr.—**FG**
Note: The only collection of *H. seticauda* Lindl. ex Benth. in CAY, *Cremers & Hoff 10717*, has been identified as *H. hamata* by Batista et al. 2008.
Habenaria longipedicellata Hoehne—**FG**
Habenaria platydactyla Kraenzl.—should be deleted
Habenaria pratensis (Salzm. ex Lindl.) Rchb. f.—should be deleted
Habenaria pratensis var. *parviflora* Cogn.—should be deleted
Habenaria schomburgkii Lindl.—**BO, GU, SU**
Habenaria schwackei Barb. Rodr.—**GU, SU, FG**
Habenaria secundiflora Barb. Rodr.—**BO, GU, FG**
Habenaria seticauda Lindl. ex Benth.—delete **FG**; it should read:—**BO, GU**
Habenaria spathulifera Cogn.—**BO, GU?, SU, FG**
Habenaria subfiliformis Cogn.—**BO, SU**
Heterotaxis proboscidea (Rchb. f.) F. Barros—should be deleted
Ligeophila clavigera var. **rhodostachys** Ormerod—**GU**
Ligeophila unicornis Ormerod—**AM**
Maxillaria nasuta Rchb. f.—should be deleted

Microchilus campanulatus Ormerod—**AM, BO, GU**
Microchilus guianensis Ormerod—**GU**
Nitidobulbon nasutum (Rchb. f.) Ojeda & Carnevali—**AM, BO, GU**
Nitidobulbon proboscidea (Rchb. f.) Ojeda & Carnevali—**AM**
Ornithidium elianae Carnevali & M.A. Blanco—**AM, GU, SU, FG**
Specklinia feuilletii Luer—**FG**

Note: In the Checklist, the species of *Specklinia* Lindl. were placed in the synonymy of *Pleurothallis* R. Br. and one in *Trichosalpinx* Luer. *Pleurothallis feuilletii* Luer 2004 (p. 237) as well as *Specklinia feuilletii* (Luer) Luer 2004 (p. 260) are invalid because they were both published in the same volume as two names for the same taxon. The only name available is *Specklinia feuilletii* Luer validated in 2005.

Synonyms and misidentifications

Habenaria platydactyla Kraenzl. = *Habenaria schwackei* Barb. Rodr.
Heterotaxis proboscidea (Rchb. f.) F. Barros = *Nitidobulbon proboscidea* (Rchb. f.) Ojeda & Carnevali
Maxillaria brevipedunculata Ames & C. Schweinf.—should read "= *Nitidobulbon nasutum* (Rchb. f.) Ojeda & Carnevali"
Maxillaria nasuta Rchb. f. = *Nitidobulbon nasutum* (Rchb. f.) Ojeda & Carnevali
Maxillaria proboscidea Rchb. f. = *Nitidobulbon proboscidea* (Rchb. f.) Ojeda & Carnevali
Pleurothallis feuilletii Luer (invalid) = *Specklinia feuilletii* Luer

References

Batista, J.A.N., J.B.F. da Silva, and L. de Bem Bianchetti. 2008. The genus *Habenaria* (Orchidaceae) in the Brazilian Amazon. Rev. Brasil. Bot. 31:105–134.

Blanco, M.A., G. Carnevali, D. Bogarín, and R.B. Singer. 2008. Further disentangling of a taxonomic puzzle: *Maxillaria ramosa*, *Ornithidium pendulum*, and a new species, *O. ellianae* (Orchidaceae). Harvard Pap. Bot. 13:135–154.

Luer, C.A. 2004. *Pleurothallis* subgen. *Acianthera* and three allied subgenera; A second century of new species of *Stelis* of Ecuador; *Epibator*, *Ophidion*, *Zootrophion*. Monogr. Syst. Bot. Missouri Bot. Gard. 95:1–265.

Luer, C.A. 2005. Validation of names cited in Monogr. Syst. Bot. Missouri Bot. Gard. 95. 2004. Monogr. Syst. Bot. Missouri Bot. Gard. 103:310–311.

Ojeda I., G. Carnevali, and G.A. Romero-González. 2009. *Nitidobulbon*, a new genus of Maxillariinae (Orchidaceae). Novon 19:96–101.

Ormerod, P. 2008. Studies of neotropical Goodyerinae (Orchidaceae) 3. Harvard Pap. Bot. 13:55–87.

POACEAE (p. 149–172)

Apochloa chnoodes (Trin.) Zuloaga & Morrone—**AM, BO, GU**
Apochloa eligulata (N.E. Br.) Zuloaga & Morrone—**BO**
Apochloa jauana (Davidse) Zuloaga & Morrone—**BO**
Apochloa sipapoensis (Swallen) Zuloaga & Morrone—**AM, BO**
Apochloa steyermarkii (Swallen) Zuloaga & Morrone—**BO**
Arthrostylidium berryi Judziewicz & Davidse—**AM**
Panicum chnoodes Trin.—should be deleted
Panicum eligulatum N.E. Br.—should be deleted
Panicum jauanum Davidse—should be deleted
Panicum sipapoense Swallen—should be deleted
Panicum steyermarkii Swallen—should be deleted
Raddiella vanessiae Judziewicz & Sepsenwol—**FG**

Synonyms and misidentifications

Panicum auyanense Swallen—should read "= *Apochloa eligulata* (N.E. Br.) Zuloaga & Morrone"
Panicum chnoodes Trin. = *Apochloa chnoodes* (Trin.) Zuloaga & Morrone
Panicum churunense Swallen—should read "= *Apochloa chnoodes* (Trin.) Zuloaga & Morrone"
Panicum cowanii Swallen—should read "= *Apochloa chnoodes* (Trin.) Zuloaga & Morrone"
Panicum curvifolium Swallen—should read "= *Apochloa chnoodes* (Trin.) Zuloaga & Morrone"
Panicum eligulatum N.E. Br. = *Apochloa eligulata* (N.E. Br.) Zuloaga & Morrone
Panicum fontanale Swallen—should read "= *Apochloa steyermarkii* (Swallen) Zuloaga & Morrone"
Panicum inversum Swallen—should read "= *Apochloa chnoodes* (Trin.) Zuloaga & Morrone"
Panicum jauanum Davidse = *Apochloa jauana* (Davidse) Zuloaga & Morrone
Panicum kavanayense Swallen—should read "= *Apochloa chnoodes* (Trin.) Zuloaga & Morrone"
Panicum maguirei Swallen—should read "= *Apochloa chnoodes* (Trin.) Zuloaga & Morrone"
Panicum sipapoense Swallen = *Apochloa sipapoensis* (Swallen) Zuloaga & Morrone
Panicum steyermarkii Swallen = *Apochloa steyermarkii* (Swallen) Zuloaga & Morrone
Panicum tatei Swallen—should read "= *Apochloa chnoodes* (Trin.) Zuloaga & Morrone"
Panicum tropinoblephare Tutin—should read "= *Apochloa chnoodes* (Trin.) Zuloaga & Morrone"
Panicum vannum Swallen—should read "= *Apochloa chnoodes* (Trin.) Zuloaga & Morrone"
Panicum wurdackii Swallen—should read "= *Apochloa eligulata* (N.E. Br.) Zuloaga & Morrone"

References

Judziewicz, E.J. and G. Davidse. 2008. *Arthrostylidium berryi* (Poaceae, Bambusoideae, Bambuseae, Arthrostylidiinae), a new species from white sand shrublands in Venezuela and Colombia. Novon 18:361–365.

Judziewicz, E.J. and S. Sepsenwol. 2007. The world's smallest bamboo: *Raddiella vanessiae* (Poaceae: Bambusoideae: Olyreae), a new species from French Guiana. J. Bot. Res. Inst. Texas 1:1–7.

Sede, S.M., O. Morrone, L.M. Giussani, and F.O. Zuloaga. 2008. Phylogenetic studies in the Paniceae (Poaceae): a realignment of section *Lorea* of *Panicum*. Syst. Bot. 33:284–300.

ANTHOPHYTA: DICOTYLEDONAE

ACANTHACEAE (p. 183–187)

Asystasia gangetica (L.) T. Anderson—add **FG**

Note: Common weed around villages. Several specimens, cf. *C. Feuillet 26* (CAY, P, US)

Synonyms and misidentifications

Ruellia fulgens (Bremek.) E. Tripp = *Polylychnis fulgens* Bremek.

Note: The merge of *Polylychnis* in *Ruellia* might be the right thing to do, but the other species of *Polylychnis* in the *Checklist* area has not been transferred. It seems better to keep them together in this regional work.

Reference

Tripp, E.A. 2007. Evolutionary relashionships within the species-rich genus *Ruellia* (Acanthaceae). Syst. Bot. 32:628–649.

ANNONACEAE (p. 190–195)

Guatteria alticola Scharf & Maas—**GU**
Guatteria anteridifera Scharf & Maas—**FG**
Guatteria anthracina Scharf & Maas—**GU, SU, FG**
Guatteria ayangannae Scharf & Maas—**GU**
Guatteria elegans Scharf—**FG**
Guatteria intermedia Scharf—**SU, FG**
Guatteria leucotricha Scharf & Maas—**FG**
Guatteria minutiflora Scharf & Maas—**GU, SU**
Guatteria montis-trinitatis Scharf—**FG**
Guatteria pakaraimae Scharf & Maas—**GU**
Guatteria pannosa Scharf & Maas—**FG**
Guatteria partangensis Scharf & Maas—**GU**
Guatteria richardii R.E. Fr.—add **SU**
Guatteria wokomungensis Scharf & Maas—**GU**
Unonopsis spectabilis Diels—**AM, BO**
Unonopsis velutina Maas—should be deleted

Synonyms and misidentifications

Unonopsis velutina Maas = *Unonopsis spectabilis* Diels

References

Maas, P.J.M., L.Y.T. Westra, and M. Vermeer. 2007. Revision of the neotropical genera *Bocageopsis*, *Onychopetalum*, and *Unonopsis* (Annonaceae). Blumea 52:413–554.

Scharf, U., P.J.M. Maas, and W. Morawetz. 2006. *Guatteria richardii* (Annonaceae) rediscovered along with two new species from French Guiana. Blumea 51:541–552.

Scharf, U., P.J.M. Maas, and W. Morawetz. 2005. Five new species of *Guatteria* (Annonaceae) from the Pakaraima Mountains, Guyana. Blumea 50:563–573.

Scharf, U., P.J.M. Maas, and W. Morawetz. 2006. Five new species of *Guatteria* (Annonaceae) from French Guiana, Guyana and Suriname. Blumea 51:117–130.

Scharf, U., P.J.M. Maas, and M.-F. Prévost. 2008. An unusual new species of *Guatteria* (Annonaceae) from French Guiana and adjacent Brazil (Amapá). Blumea 53:515–523.

ARISTOLOCHIACEAE (p. 207–208)

Note: The replacement late in the process of the invalid *Aristolochia peltato-deltoidea* Hoehne with *Aristolochia kanukuensis* Feuillet upset the alignment between the checklist text and the distribution table, between k and p. The following species should read as follows.

Aristolochia kanukuensis Feuillet—delete "ined.," correct author spelling—**GU**
Aristolochia leprieurii Duch.—**GU, FG**
Aristolochia melgueiroi Barringer & Guánchez—**AM, BO**
Aristolochia mossii S. Moore—**AM, BO, FG**
Aristolochia nummularifolia Kunth—**AM, BO**
Aristolochia pannosoides Hoehne—**BO**
Aristolochia paramaribensis Duch.—**GU, SU, FG**

Reference

Feuillet, C. 2007. Folia taxonomica 1. Validation of two taxa from northern South America. J. Bot. Res. Inst. Texas 1:143–144.

BORAGINACEAE (p. 224–226)

Cordia bullata (L.) Roem. & Schult.—should be deleted
Cordia bullata subsp. *humilis* (Jacq.) Gaviria—should be deleted
Cordia cremersii Feuillet—should be deleted
Cordia curassavica (Jacq.) Roem. & Schult.—should be deleted
Cordia grandiflora (Desv.) Kunth—should be deleted
Cordia marioniae Feuillet—should be deleted
Cordia multispicata Cham.—should be deleted
Cordia polycephala (Lam.) I.M. Johnst.—should be deleted
Cordia polystachya Kunth—should be deleted
Cordia roraimae I.M. Johnst.—should be deleted
Cordia schomburgkii DC.—should be deleted
Cordia stenostachya Killip ex Gaviria—should be deleted
Cordia steyermarkii Gaviria—should be deleted
Cordia tomentosa (Lam.) Roem. & Schult.—should be deleted
Euploca filiformis (Lehm.) J.I.M. Melo & Semir—**AM, BO, GU, SU, FG**
Euploca lagoensis (Warm.) Diane & Hilger—**BO, SU**
Euploca polyphylla (Lehm.) J.I.M. Melo & Semir—**BO**
Euploca procumbens (Mill.) Diane & Hilger—**AM, BO, DA, GU**

Euploca ternata (Vahl) J.I.M. Melo & Semir—**BO, GU**
Heliotropium filiforme Lehm.—should be deleted
Heliotropium lagoense (Warm.) Gürke—should be deleted
Heliotropium polyphyllum Lehm.—should be deleted
Heliotropium procumbens Mill.—should be deleted
Heliotropium ternatum Vahl—should be deleted
Myriopus candidulus (Miers) Feuillet—**BO, GU**
Myriopus maculatus (Jacq.) Feuillet—**BO, GU, SU, FG**
Myriopus paniculatus (Cham.) Feuillet—**GU, SU, FG**
Myriopus paniculatus var. **spigeliiflorus** (A. DC.) Feuillet—**GU, SU, FG**
Myriopus volubilis (L.) Small—**BO, GU, FG**
Tournefortia candidula (Miers) I.M. Johnst.—should be deleted
Tournefortia maculata Jacq.—should be deleted
Tournefortia paniculata Cham.—should be deleted
Tournefortia paniculata var. *spigeliiflora* (A. DC.) I.M. Johnst.—should be deleted
Tournefortia volubilis L.—should be deleted
Varronia bullata L.—**BO, DA, GU?**
Varronia bullata subsp. **humilis** (Jacq.) Feuillet—**BO, DA, GU?**
Varronia cremersii (Feuillet) Feuillet—**FG**
Varronia curassavica Jacq.—**AM, BO, DA, GU, SU, FG**
Varronia grandiflora Desv.—**AM, BO, DA, GU**
Varronia marioniae (Feuillet) Feuillet—**GU**
Varronia polycephala Lam.—**BO, GU, SU, FG**
Varronia polystachya (Kunth) Borhidi—**AM**
Varronia roraimae (I.M. Johnst.) J.S. Mill.—**BO**
Varronia schomburgkii (DC.) Borhidi—**BO, GU, SU, FG**
Varronia stenostachya (Gaviria) J.S. Mill.—**AM, GU**
Varronia steyermarkii (Gaviria) J.S. Mill.—**BO**
Varronia tomentosa Lam.—**SU, FG**

Synonyms and misidentifications

Cordia bullata (L.) Roem. & Schult. = *Varronia bullata* L.
Cordia bullata subsp. *humilis* (Jacq.) Gaviria = *Varronia bullata* subsp. *humilis* (Jacq.) Feuillet
Cordia cremersii Feuillet = *Varronia cremersii* (Feuillet) Feuillet
Cordia curassavica (Jacq.) Roem. & Schult. = *Varronia curassavica* Jacq.
Cordia cylindrostachya (Ruiz & Pav.) Roem. & Schult. [misidentification for *Varronia schomburgkii* (DC.) Borhidi]
Cordia ferruginea (Lam.) Roem. & Schult. [misidentification for *Varronia schomburgkii* (DC.) Borhidi]
Cordia grandiflora (Desv.) Kunth = *Varronia grandiflora* Desv.
Cordia marioniae Feuillet = *Varronia marioniae* (Feuillet) Feuillet
Cordia multispicata Cham. [not in our area]
Cordia polycephala (Lam.) I.M. Johnst. = *Varronia polycephala* Lam.
Cordia polystachya Kunth = *Varronia polystachya* (Kunth) Borhidi
Cordia roraimae (I.M. Johnst.) J.S. Mill. = *Varronia roraimae* (I.M. Johnst.) J.S. Mill.
Cordia schomburgkii DC. = *Varronia schomburgkii* (DC.) Borhidi
Cordia spinescens (L.) Borhidi [misidentification for *Varronia schomburgkii* (DC.) Borhidi]
Cordia stenostachya Killip ex Gaviria = *Varronia stenostachya* (Gaviria) J.S. Mill.
Cordia steyermarkii Gaviria = *Varronia steyermarkii* (Gaviria) J.S. Mill.
Cordia tomentosa (Lam.) Roem. & Schult. = *Varronia tomentosa* Lam.
Heliotropium filiforme Lehm. = *Euploca filiformis* (Lehm.) J.I.M. Melo & Semir
Heliotropium foliosum Roem. & Schult.—should read "= *Euploca polyphylla* (Lehm.) J.I.M. Melo & Semir"
Heliotropium fumana (Fresen.) Gürke—should read "= *Euploca ternata* (Vahl.) J.I.M. Melo & Semir"
Heliotropium lagoense (Warm.) Gürke = *Euploca lagoensis* (Warm.) Diane & Hilger
Heliotropium ottonis Lehm.—should read "= *Euploca ternata* (Vahl.) J.I.M. Melo & Semir"
Heliotropium polyphyllum Lehm. = *Euploca ternata* (Vahl.) J.I.M. Melo & Semir
Heliotropium procumbens Mill. = *Euploca procumbens* (Mill.) Diane & Hilger
Heliotropium ternatum Vahl = *Euploca ternata* (Vahl) J.I.M. Melo & Semir
Heliotropium trinitensis Urb.—should read "= *Euploca lagoensis* (Warm.) Diane & Hilger"
Messerschmidia candidula Miers = *Myriopus candidulus* (Miers) Feuillet
Schleidenia fumana Fresen.—should read "= *Euploca ternata* (Vahl.) J.I.M. Melo & Semir"
Schleidenia lagoensis Warm.—should read "= *Euploca lagoensis* (Warm.) Diane & Hilger"
Schleidenia polyphylla (Lehm.) Fresen.—should read "= *Euploca polyphylla* (Lehm.) J.I.M. Melo & Semir"
Tournefortia candidula (Miers) I.M. Johnst. = *Myriopus candidulus* (Miers) Feuillet
Tournefortia maculata Jacq. = *Myriopus maculatus* (Jacq.) Feuillet
Tournefortia paniculata Cham. = *Myriopus paniculatus* (Cham.) Feuillet
Tournefortia paniculata var. *spigeliiflora* (A. DC.) I.M. Johnst. = *Myriopus paniculatus* var. *spigeliiflorus* (A. DC.) Feuillet
Tournefortia spigeliaeflora A. DC. = *Myriopus paniculatus* var. *spigeliiflorus* (A. DC.) Feuillet
Tournefortia volubilis L. = *Myriopus volubilis* (L.) Small

References

Feuillet, C. 2008. Folia taxonomica 4. Conspectus of *Myriopus* (Heliotropiaceae, Boraginales) in the Guiana Shield. J. Bot. Res. Inst. Texas 2:263–265.

Feuillet, C. 2008. Folia taxonomica 11. Conspectus of *Varronia* (Cordiaceae, Boraginales) in the Guiana Shield with three new combinations. J. Bot. Res. Inst. Texas 2:837–842.

Melo, J.I.M. de. 2009. Two new Brazilian species and new combinations in *Euploca* (Heliotropiuaceae). Kew Bull. 64:285–289.

BURSERACEAE (p. 227–231)

Protium calendulinum Daly—**AM, FG**
Protium retusum Daly—**GU**
Protium urophyllidium Daly—**AM**

Reference

Daly, D.C. 2007. A new section of *Protium* from the Neotropics. Studies in neotropical Burseraceae XIII. Brittonia 59:1–24.

CAPPARACEAE (p. 234–235)

Capparis flexuosa subsp. *polyantha* (Triana & Planch.) H.H. Iltis—should be deleted
Capparis leprieurii Briquet—should be deleted
Capparis maroniensis Benoist—should be deleted
Capparis muco H.H. Iltis, L. Cumaná, R. Delgado & Aymard—should be deleted
Cynophalla polyantha (Triana & Planch.) X. Cornejo & H.H. Iltis—**BO, SU**
Neocalyptrocalyx leprieurii (Briquet) H.H. Iltis—**GU, SU, FG**
Neocalyptrocalyx maroniensis (Benoist) X. Cornejo & H.H. Iltis—**BO, GU, SU, FG**
Neocalyptrocalyx morii X. Cornejo & H.H. Iltis—**FG**
Neocalyptrocalyx muco (H.H. Iltis, L. Cumaná, R. Delgado & Aymard) X. Cornejo & H.H. Iltis—**BO**

Synonyms and misidentifications

Capparis flexuosa subsp. *polyantha* (Triana & Planch.) H.H. Iltis = *Cynophalla polyantha* (Triana & Planch.) X. Cornejo & H.H. Iltis
Capparis leprieurii Briquet = *Neocalyptrocalyx leprieurii* (Briquet) H.H. Iltis
Capparis maroniensis Benoist = *Neocalyptrocalyx maroniensis* (Benoist) X. Cornejo & H.H. Iltis
Capparis muco H.H. Iltis, L. Cumaná, R. Delgado & Aymard = *Neocalyptrocalyx muco* (H.H. Iltis, L. Cumaná, R. Delgado & Aymard) X. Cornejo & H.H. Iltis
Capparis polyantha Triana & Planch. = *Cynophalla polyantha* (Triana & Planch.) X. Cornejo & H.H. Iltis

References

Cornejo, X. and H.H. Iltis. 2008. Two new genera of Capparaceae: *Sarcotoxicum* and *Mesocapparis* stat. nov., and the reinstatement of *Neocalyptrocalyx*. Harvard Pap. Bot. 13:103–116.

Cornejo, X. and H.H. Iltis. 2008. New combinations in South American Capparaceae. Harvard Pap. Bot. 13:117–120.

Cornejo, X. and H.H. Iltis. 2008. *Neocalyptrocalyx morii* (Capparaceae), a new species from Central French Guiana. J. Bot. Res. Inst. Texas 2:807–810.

CLUSIACEAE (p. 247–253)

Tovomita gazelii Poncy & Offroy—**FG**

Reference

Poncy, O. and B. Offroy. 2006. Une nouvelle espèce de *Tovomita* Aubl. (Clusiaceae) de Guyane française. Adansonia, sér. 3, 28(1):113–117.

COMBRETACEAE (p. 254–255)

The references are misplaced on the bottom of page 253 after those of the Clusiaceae.

COMPOSITAE (p. 255–269)

Galinsoga parviflora Cab.—**GU**

DROSERACEAE (p. 282)

Drosera solaris A. Fleischm., Wistuba & S. McPherson—**GU**

Reference

Fleischmann, A., A. Wistuba, and S. McPherson. 2007. *Drosera solaris* (Droseraceae), a new sundew from the Guayana Highlands. Willdenowia 37:551–555.

EBENACEAE (p. 282–283)

Diospyros gallo B. Walln.—**BO**
Diospyros ottohuberi B. Walln.—**BO**
Diospyros tepu B. Walln.—**BO**

Reference

Wallnöfer, B. 2000. Neue *Diospyros*-Arten (Ebenaceae) aus Südamerika—II. Ann. Naturhist. Mus. Wien, ser. B, 102:419–432.

EUPHORBIACEAE (p. 290–300)

Paul Berry

Astraea lobata (L.) Klotzsch—**BO, DA, GU, SU, FG**
Croton lobatus L.—should be deleted
Croton argyrophylloides Kunth—should be deleted
Croton argyrophyllus Kunth—should be only **BO**
Croton cajucara Benth.—add **FG**
Croton essequiboensis Klotzsch—remove "[=*Croton populifolius* P. Mill.?]"
Croton kaieteuri Jabl.—should be deleted
Croton kavanayensis Steyerm.—should be deleted
Croton aff. *nepetifolius* Baill.—should replace *Croton nepetifolius*
Croton niveus Jacq.—**BO**
Croton polypleurus Croizat—add **AM**
Croton rhamnifolius Kunth—should be deleted
Croton roraimensis var. *roraimensis*—should be deleted
Croton rottlerifolius Baill.—should be deleted
Croton sacaquinha Croizat—**GU**
Croton sampatik Muell. Arg.—**AM**
Croton sp. A—should be deleted
Croton sp. B—should be deleted
Croton sp. G—should be deleted
Croton sp. H—should be deleted
Croton sp. X [= *Croton nervosus* Klotzsch, nom. illeg.]—**AM, BO, GU**
Croton tricolor Klotzsch—**FG**
Euphorbia comosa Vell.—erase "**SU?**"
Euphorbia aff. *laurifolia* Juss.—should be deleted

Euphorbia pulcherrima Willd. Ex Klotsch—correct epithet spelling & add **FG**

Euphorbia tirucalli L.—add **FG**

Euphorbia tithymaloides L.—**BO, GU, SU, FG**

Euphorbia tithymaloides subsp. **tithymaloides** [native to **GU, SU**; cultivated in all; collected from]—**BO, GU, SU, FG**

Manihot baccata Allem—**FG**

Micrandra sp. A—should be deleted

Micrandra spruceana (Baill.) R.E. Schult.—remove the mention "[record probably misident.]"

Note: Next species in the Checklist, *M. sprucei* (Muell. Arg.) R.E. Schult., is a different species also present in the area covered by the checklist.

Synonyms and misidentifications

Chamaescye adenoptera (Bertol.) Small = *Euphorbia dioeca*—should be deleted

Note: They are two different species and *C. adenoptera* is not in our area.

Croton argyrophylloides Kunth = *Croton tricolor* Klotzsch

Croton barlettii Lanj.—should be deleted

Croton glandulosus subsp. *hirtus* (L'Hérit.) Croizat, "Bull."—should be deleted

Note: In the Checklist it is a repeat of the entry 2 lines above: "*Croton glandulosus* subsp. *hirtus* (L'Hérit.) Croizat."

Croton kaieteuri Jabl. = *Croton cuneatus* Klotzsch

Croton kavanayensis Steyerm. = *Croton matourensis* Aubl.

Croton lobatus L. = *Astraea lobata* (L.) Klotzsch

Croton micans Sw. = *Croton argyrophyllus*—instead of "=" it should read "misidentification for"

Croton nervosus Klotzsch [nom. illeg.] = *Croton argyrophyllus*—should read "= *Croton* sp. X"

Croton populifolius P. Mill.—should be deleted

Croton rhamnifolius Kunth (illeg.) = *Croton conduplicatus* Kunth

Croton sp. A = *Croton parodianus* Croizat

Croton sp. B = *Croton sampatik* Muell. Arg.

Croton sp. G = *Croton polypleurus* Croizat

Croton sp. H = *Croton niveus* Jacq.

Euphorbia aff. *laurifolia* Juss. [misidentification; Andean species]

Euphorbia tithymaloides L.—should be deleted

Euphorbia tithymaloides subsp. *tithymaloides*—should be deleted

Micrandra sp. A = *Micrandra inundata* P.E. Berry & Wiedenhoeft

Pedilanthus tithymaloides (L.) Poit. = *Euphorbia tithymaloides* L.

Pedilanthus tithymaloides subsp. *tithymaloides* = *Euphorbia tithymaloides* subsp. *tithymaloides*

Reference

Allem, A.C. 1999. A new species of *Manihot* (Euphorbiaceae) from the Brazilian Amazon. Int. J. Plant Sci. 160:181–187.

GENTIANACEAE (p. 304–309)

Curtia ayangannae L. Cobb & Jans.-Jac.—**GU**

Reference

Cobb, L., M.J. Jansen-Jacobs, and R. van der Ham. 2007. *Curtia ayangannae*, a new species of Gentianaceae from the Pakaraima Mountains, Guyana. Blumea 52:5–10.

GESNERIACEAE (p. 309–312)

C. Feuillet and L.E. Skog

Alloplectus cristatus (L.) Mart.—should be deleted

Alloplectus cristatus var. *epirotes* Leeuwenb.—should be deleted

Alloplectus savannarum C.V. Morton—should be deleted

Besleria neblinae Feuillet—**AM**

Besleria sp. A—should be deleted

Besleria sp. B—should be deleted

Besleria sp. C—should be deleted

Besleria yatuana Feuillet—**AM**

Crantzia epirotes (Leeuwenb.) J.L. Clark—**GU**

Episcia duidae Feuillet—**AM**

Episcia rubra Feuillet—**AM**

Episcia sp. A—should be deleted

Episcia sp. B—should be deleted

Gloxinia erinoides (DC.) E.H. Roalson & J.K. Boggan—**BO**

Gloxinia purpurascens (Rusby) Wiehler—should be deleted

Koellikeria erinoides (DC.) Mansf.—should be deleted

Nautilocalyx crenatus Feuillet—**AM**

Nautilocalyx orinocensis Feuillet—**AM**

Nautilocalyx paujiensis Feuillet—**BO**

Nautilocalyx pusillus Feuillet—**BO**

Nautilocalyx roseus Feuillet—**BO**

Nautilocalyx ruber Feuillet—**AM**

Nautilocalyx sp. A—should be deleted

Nautilocalyx sp. B—should be deleted

Nautilocalyx sp. C—should be deleted

Nautilocalyx sp. D—should be deleted

Nautilocalyx sp. E—should be deleted

Nautilocalyx sp. F—should be deleted

Nautilocalyx sp. G—should be deleted

Nautilocalyx vestitus Feuillet—**BO**

Nematanthus savannarum (C.V. Morton) J.L. Clark—**BO, GU, SU**

Paradrymonia glandulosa Feuillet—**AM**

Paradrymonia hamata Feuillet—**AM**

Paradrymonia maculata (Hook. f.) Wiehler—add **DA**

Paradrymonia lutea Feuillet—**AM**

Paradrymonia maguirei Feuillet—**AM**

Paradrymonia sp. A—should be deleted

Paradrymonia sp. B—should be deleted

Paradrymonia sp. C—should be deleted

Paradrymonia sp. D—should be deleted

Paradrymonia sp. E—should be deleted

Paradrymonia tepui Feuillet—**AM**

Paradrymonia yatua Feuillet—**AM**

Seemannia purpurascens Rusby—**GU, FG**

Synonyms and misidentifications

Alloplectus cristatus var. *epirotes* Leeuwenb. = *Crantzia epirotes* (Leeuwenb.) J.L. Clark

Alloplectus savannarum C.V. Morton = *Nematanthus savannarum* (C.V. Morton) J.L. Clark
Besleria sp. A = *Besleria neblinae* Feuillet
Besleria sp. B = *Besleria neblinae* Feuillet
Besleria sp. C = *Besleria yatuana* Feuillet
Episcia sp. A = *Episcia rubra* Feuillet
Episcia sp. B = *Episcia duidae* Feuillet
Gloxinia purpurascens (Rusby) Wiehler = *Seemannia purpurascens* Rusby
Koellikeria erinoides (DC.) Mansf. = *Gloxinia erinoides* (DC.) E.H. Roalson & J.K. Boggan
Nautilocalyx sp. A = *Nautilocalyx vestitus* Feuillet
Nautilocalyx sp. B = *Nautilocalyx orinocensis* Feuillet
Nautilocalyx sp. C = *Nautilocalyx roseus* Feuillet
Nautilocalyx sp. D = *Nautilocalyx paujiensis* Feuillet
Nautilocalyx sp. E = *Nautilocalyx ruber* Feuillet
Nautilocalyx sp. F = *Nautilocalyx crenatus* Feuillet
Nautilocalyx sp. G = *Nautilocalyx pusillus* Feuillet
Paradrymonia sp. A = *Paradrymonia lutea* Feuillet
Paradrymonia sp. B = *Paradrymonia hamata* Feuillet
Paradrymonia sp. C = *Paradrymonia glandulosa* Feuillet
Paradrymonia sp. D = *Paradrymonia tepui* Feuillet
Paradrymonia sp. E = *Paradrymonia maguirei* Feuillet

References

Clark, J.L. 2005. A Monograph of *Alloplectus* (Gesneriaceae). Selbyana 25:182–209.

Feuillet, C. 2008. Folia Taxonomica 6. Two new species of *Besleria* (Gesneriaceae) from the Venezuelan Guayana J. Bot. Res. Inst. Texas 2:269–273.

Feuillet, C. 2008. Folia Taxonomica 7. Two new species and a new section in *Episcia* (Gesneriaceae) from the Venezuelan Guayana. J. Bot. Res. Inst. Texas 2:275–280.

Feuillet, C. 2008. Folia Taxonomica 10. New species of *Nautilocalyx* (Gesneriaceae: Episcieae) from the Venezuelan Guayana. J. Bot. Res. Inst. Texas 2:825–836.

Feuillet, C. 2009. Folia Taxonomica 12. *Paradrymonia* (Gesneriaceae, Episcieae) from the Guiana Shield: *P. maguirei* a new species from Amazonas, and distribution and floral morphology of *P. maculata.* J. Bot. Res. Inst. Texas 3:133–138.

Feuillet, C. 2009. Folia Taxonomica 15. Five new species of *Paradrymonia* subgenus *Paradrymonia* (Gesneriaceae, Episcieae) from the Venezuelan Guayana. J. Bot. Res. Inst. Texas 3:583–592.

Roalson, E.H., J.K. Boggan, and L.E. Skog. 2005. Reorganization of tribal and generic boundaries in the Gloxinieae (Gesneriaceae: Gesnerioideae) and the description of a new tribe in the Gesnerioideae, Sphaerorrhizeae. Selbyana 25:225–238.

Skog, L.E. and C. Feuillet. 2008. Gesneriaceae. In: M.J. Jansen-Jacobs, ed. Flora of the Guianas ser. A, 26. 136 pages. Royal Botanic Gardens Kew, Richmond.

HIPPOCRATEACEAE (p. 313–314)

In the family authors, after Mennega, delete "†"

LEGUMINOSAE-CAESALPINIOIDEAE (p. 333–346)

Paloue sandwithii Redden—**GU**

Reference

Redden, K.M. 2008. A new species of *Paloue* (Leguminosae: Caesalpinioideae: Detarieae) from Guyana, South America. Brittonia 60:257–260.

LEGUMINOSAE-FABOIDEAE (p. 346–365)

Aldina diplogyne Stergios & Aymard—**BO**
Guianodendron praeclarum (Sandwith) Schütz Rodrigues & Azevedo—**GU**
Swartzia anomala R.S. Cowan—add **GU**
Swartzia benthamiana var. *yatuensis* R.S. Cowan—should be deleted
Swartzia brachyrachis Harms—should be deleted
Swartzia brachyrachis var. *glabrata* R.S. Cowan—should be deleted
Swartzia canescens Torke—**FG, SU**
Swartzia glabrata (R.S. Cowan) Torke—**BO, GU, SU**
Swartzia kaieteurensis Torke—delete "sp. nov. ined."
Swartzia ramiflora Torke—**AM**
Swartzia rosea Mart. ex Benth.—**AM**
Swartzia stipellata R.S. Cowan—should be deleted
Trischidium alternum (Benth.) H.E. Ireland—**GU**

Synonyms and misidentifications

Bocoa alterna (Benth.) R.S. Cowan = *Trischidium alternum* (Benth.) H.E. Ireland
Swartzia alterna Benth. = *Trischidium alternum* (Benth.) H.E. Ireland
Swartzia benthamiana var. *yatuensis* R.S. Cowan = *Swartzia rosea* Mart. ex Benth.
Swartzia brachyrachis var. *glabrata* R.S. Cowan = *Swartzia glabrata* (R.S. Cowan) Torke
Swartzia stipellata R.S. Cowan = *Swartzia anomala* R.S. Cowan

References

Ireland, H.E. 2007. Taxonomic changes in the South American genus *Bocoa* (Leguminosae-Swartzieae): reinstatement of the name *Trischidium,* and a synopsis of both genera. Kew Bull. 62:333–350.

Schütz Rodrigues, R. and A.M.G. Azevedo. 2006. *Guianodendron*, a new genus of Leguminosae (Papilionoideae) from South America. Novon 16:129–132.

Stergios, B. and G.A. Aymard. 2008. A striking new species of *Aldina* (Fabaceae-Swartzieae-Aldinae) from the Venezuelan Guayana highlands. Harvard Pap. Bot. 13(1):29–33.

Torke, B.M. 2007. New combinations and species-level synonyms in *Swartzia* (Leguminosae: Papilionoideae). Novon 17:110–119.

Torke, B.M. 2007. Three new species of *Swartzia* (Leguminosae-Papilionoideae) from northern South America. Bot. J. Linn Soc. 153:343–355.

LEGUMINOSAE-MIMOSOIDEAE (p. 365–376)

Inga loubryana Poncy—**GU, FG**

Reference

Poncy, O. 2007. A new species of *Inga* Mill. (Fabaceae, Mimosoideae) from the Guianas. Adansonia sér. 3, 29(2):249–254.

LISSOCARPACEAE (p. 379)

Two of the references by Wallnöfer placed in the Ebenaceae belong here.

LORANTHACEAE (p. 381–384)

Oryctina atrolineata Kuijt—**GU**

Reference

Kuijt, J. 2003. A new species of *Oryctina* (Loranthaceae) from Guyana. Brittonia 55:169–172.

MALPIGHIACEAE (p. 386–393)

Alicia macrodisca (Triana & Planch.) W.R. Anderson—**AM, BO GU, SU**
Carolus sinemariensis (Aubl.) W.R. Anderson—**AM, BO, GU, FG**
Christianella glandulifera (Cuatrec.) W.R. Anderson—**AM**
Christianella surinamensis (Kosterm.) W.R. Anderson—**AM, GU, SU**
Malpighiodes guianensis (W.R. Anderson) W.R. Anderson—**GU, SU, FG**
Malpighiodes liesneri (W.R. Anderson) W.R. Anderson—**AM**
Mascagnia castanea (Cuatrec.) W.R. Anderson—should be deleted
Mascagnia glandulifera Cuatrec.—should be deleted
Mascagnia guianensis W.R. Anderson—should be deleted
Mascagnia liesneri W.R. Anderson—should be deleted
Mascagnia macrodisca (Triana & Planch.) Nied.—should be deleted
Mascagnia microcarpa (Sandwith) W.R. Anderson—should be deleted
Mascagnia sinemariensis (Aubl.) Griseb.—should be deleted
Mascagnia surinamensis (Kosterm.) W.R. Anderson—should be deleted
Niedenzuella acutifolia (Cav.) W.R. Anderson—**GU, SU, FG**
Niedenzuella castanea (Cuatrec.) W.R. Anderson—**AM**
Niedenzuella poeppigiana (A. Juss.) W.R. Anderson—**AM, GU**
Tetrapterys acutifolia Cav.—should be deleted
Tetrapterys poeppigiana (A. Juss.) Griseb.—should be deleted

Synonyms and misidentifications

Banisteria sinemariensis Aubl.—should read "= *Carolus sinemariensis* (Aubl.) W.R. Anderson"
Diplopterys microcarpa (Sandwith) W.R. Anderson—should read "= *Carolus sinemariensis* (Aubl.) W.R. Anderson"
Heteropterys castanea (Cuatrec.) W.R. Anderson—should read "= *Niedenzuella castanea* (Cuatrec.) W.R. Anderson"
Hiraea macrodisca (Triana & Planch.) Nied.—should read "= *Alicia macrodisca* (Triana & Planch.) W.R. Anderson"
Hiraea poeppigiana A. Juss.—should read "= *Niedenzuella poeppigiana* (A. Juss.) W.R. Anderson"
Hiraea schizoptera Turcz.—should read "= *Carolus sinemariensis* (Aubl.) W.R. Anderson"
Malpighia volubilis Sims—should read "= *Carolus sinemariensis* (Aubl.) W.R. Anderson"
Mascagnia castaneaa (Cuatrec.) W.R. Anderson = *Niedenzuella castanea* (Cuatrec.) W.R. Anderson
Mascagnia anisopetala var. *macrodisca* (Triana & Planch.) Kosterm.—should read "= *Alicia macrodisca* (Triana & Planch.) W.R. Anderson"
Mascagnia glandulifera Cuatrec.—should read "= *Christianella glandulifera* (Cuatrec.) W.R. Anderson"
Mascagnia guianensis W.R. Anderson—should read "= *Malpighiodes guianensis* (W.R. Anderson) W.R. Anderson"
Mascagnia hondensis (Sandwith) W.R. Anderson—should read "= *Carolus sinemariensis* (Aubl.) W.R. Anderson"
Mascagnia liesneri W.R. Anderson—should read "= *Malpighiodes liesneri* (W.R. Anderson) W.R. Anderson"
Mascagnia macrodisca (Triana & Planch.) Nied. = *Alicia macrodisca* (Triana & Planch.) W.R. Anderson
Mascagnia microcarpa (Sandwith) W.R. Anderson = *Carolus sinemariensis* (Aubl.) W.R. Anderson
Mascagnia multiglandulosa var. *surinamensis* Kosterm. = *Christianella surinamensis* (Kosterm.) W.R. Anderson
Mascagnia poeppigiana (A. Juss.) W.R. Anderson—should be deleted
Mascagnia sinemariensis (Aubl.) Griseb. = *Carolus sinemariensis* (Aubl.) W.R. Anderson
Mascagnia subsericea Cuatrec.—should read "= *Niedenzuella poeppigiana* (A. Juss.) Griseb."
Mascagnia surinamensis (Kosterm.) W.R. Anderson = *Christianella surinamensis* (Kosterm.) W.R. Anderson
Tetrapterys acutifolia Cav. = *Niedenzuella acutifolia* (Cav.) W.R. Anderson
Tetrapterys poeppigiana (A. Juss.) Griseb.—should read "= *Niedenzuella poeppigiana* (A. Juss.) Griseb."

Reference

Anderson, W.R. 2006. Eight segragates from the neotropical genus *Mascagnia* (Malpighiaceae). Novon 16:168–204.

MORACEAE (p. 423–428)

Ficus duartei C.C. Berg & Carauta—**FG**
Ficus duckeana C.C. Berg & Ribeiro—**FG**

Ficus popenoei subsp. **malacocarpa** (Standl.) C.C. Berg—**AM, BO, DA, GU, SU, FG**

Synonyms and misidentifications

Ficus malacocarpa Standl. = *Ficus popenoei* subsp. *malacocarpa* (Standl.) C.C. Berg

References

BERG, C.C. AND J.P.P. CARAUTA. 2002 [2003]. New species of *Ficus* (Moraceae) from Brazil. Brittonia 54:236–250.

BERG, C.C. 2007. New species of *Ficus* (Moraceae) from South America. Blumea 52:569–594.

MYRSINACEAE (p. 430–434)

Cybianthus prevostiae Pipoly—correct species spelling—**FG**

Reference

PIPOLY, J.J. 1999. Two new species of Myrsinaceae from French Guiana. Brittonia 51:128–133.

MYRTACEAE (p. 434–442)

B. Holst and C. Feuillet

Calycolpus cochleatus McVaugh—*Huber 9375* (MO, VEN)—add **BO**
Calycorectes batavorum McVaugh—should be deleted
Calycorectes enormis McVaugh—should be deleted
Calycorectes guyanensis Mattos—should be deleted
Calycorectes maximus McVaugh—should be deleted
Calyptranthes forsteri O. Berg—*Oldeman B-2825* (CAY)—add **FG**
Calyptranthes pulchella DC.—*Cremers 8213* (CAY)—add **FG**
Calyptranthes sp.—was in the Checklist as *C. lepida* McVaugh
Eugenia batavorum (McVaugh) Mattos—**SU**
Eugenia enormis (McVaugh) Mattos—**BO, DA**
Eugenia exaltata O. Berg—*Acevedo et al. 5750* (CAY)—add **SU**
Eugenia gomesiana O. Berg—*Fleury 1012* (CAY)—add **FG**
Eugenia maxima (McVaugh) Mattos—**SU**
Eugenia protenta McVaugh—*Sanoja 2075* (VEN)—add **DA**
Marlierea biptera Amshoff—*Service Foretier 6259* (CAY)—add **FG**
Myrcia gonini McVaugh—*de Granville 1853* (CAY)—add **FG**
Myrcia tafelbergica Amshoff—*Oldeman T-454* (CAY)—add **FG**
Eugenia galbaoensis Mattos—**FG**

Synonyms and misidentifications

Calycorectes batavorum McVaugh = *Eugenia batavorum* (McVaugh) Mattos
Calycorectes enormis McVaugh = *Eugenia enormis* (McVaugh) Mattos
Calycorectes guyanensis Mattos = *Eugenia galbaoensis* Mattos
Calycorectes maximus McVaugh = *Eugenia maxima* (McVaugh) Mattos
Calyptranthes lepida McVaugh—misidentification for an undescribed species
Eugenia aubletiana Mattos (nom. illeg.) = *Eugenia latifolia* Aubl.
Eugenia yatuae (McVaugh) Mattos (superfluous) = *Eugenia yatuae* (McVaugh) Holst

References

HOLST, B.K. 2002. New species and notes on Myrtaceae from northern South America. Selbyana 23:137–180.

MATTOS, J.R. 1996. Novitates taxonomicas en Myrtaceae XII. Loefgrênia 108:1–2.

MATTOS, J.R. 2005. Considerações sobre *Calycorectes* Berg. Loefgrênia 120:1–24.

OCHNACEAE (p. 445–449)

Ouratea candelabra Sastre—**GU**
Ouratea jansen-jacobsiae Sastre—**GU, SU**
Ouratea miniguianensis Sastre—**FG**
Ouratea pseudogigantophylla Sastre—**SU**
Ouratea retrorsa Sastre—**FG**
Ouratea sipaliwiniensis Sastre—**SU**
Ouratea superimpressa Sastre—**GU**
Ouratea takutuensis Sastre—**GU**

References

SASTRE C. 2006. Deux nouvelles espèces d'*Ouratea* (Ochnaceae) des Guyanes. Adansonia, sér. 3, 28(1):119–127.

SASTRE C. 2007. Six nouvelles espèces d'*Ouratea* (Ochnaceae) des Guyanes. Adansonia, sér. 3, 29(1):77–91.

WALLNÖFER B. 1998: A revision of *Perissocarpa* Steyerm. & Maguire (Ochnaceae). Ann. Naturhist. Mus. Wien, ser. B, 100:683–707.

PASSIFLORACEAE (p. 454–456)

Passiflora angusta Feuillet & J.M. MacDougal—**BO, GU**
Passiflora arta Feuillet—remove "ined."—**GU**
Passiflora compar Feuillet—remove "ined."—**GU, FG**
Passiflora curva Feuillet—**FG**
Passiflora davidii Feuillet—**FG**
Passiflora foetida var. *orinocensis* (Killip) Feuillet—remove "ined."
Passiflora rufa Feuillet & J.M. MacDougal—**GU, SU, FG**
Passiflora sp. D—should be deleted
Passiflora sp. G—should be deleted
Passiflora sp. H—should be deleted
Passiflora tecta Feuillet—**BO, GU, SU?**

Synonyms and misidentifications

Passiflora sp. D = *Passiflora angusta* Feuillet & J.M. MacDougal
Passiflora sp. G = *Passiflora davidii* Feuillet
Passiflora sp. H = *Passiflora rufa* Feuillet & J.M. MacDougal

References

FEUILLET C. 2007. Folia taxonomica 1. Validation of two taxa from northern South America. J. Bot. Res. Inst. Texas 1:143–144.

FEUILLET C. 2007. Folia taxonomica 2. New species of *Passiflora* subgenus *Passiflora* (Passifloraceae) from the Guianas. J. Bot. Res. Inst. Texas 1:819–825.

FEUILLET C. 2007. Folia taxonomica 3. *Passiflora davidii*

(Passifloraceae), a new species in subgenus *Passiflora* and a key to the sections of supersection *Stipulata*. J. Bot. Res. Inst. Texas 1:895–898.

Feuillet C. 2008. Folia taxonomica 8. *Passiflora tecta*, a new species in subgenus *Passiflora* from the Guianas. J. Bot. Res. Inst. Texas 2:281–283.

Feuillet C. 2009. Folia taxonomica 13. *Passiflora curva* (Passifloraceae), a new species in subg. *Passiflora* supersect. *Coccinea* from French Guiana. J. Bot. Res. Inst. Texas 3:577–579.

Feuillet C. and J.M. MacDougal 2008. Folia taxonomica 9. New species of *Passiflora* subg. *Decaloba* (Passifloraceae) from northern South America. J. Bot. Res. Inst. Texas 2:817–824.

PIPERACEAE (p. 458–466)

Piper aulacospermum Callejas—**FG**
Piper ciliomarginatum Görts & Christenh.—**GU**
Piper remotinervium Görts—**GU, FG**

Reference

Görts-van Rijn, A.R.A. and R. Callejas. 2005. Three new species of *Piper* (Piperaceae) from the Guianas. Blumea 50:367–373.

RUBIACEAE (p. 479–507)

P.G. Delprete

The molecular phylogenies published by Razafimandimbison et al. (2009) support the separation of *Appunia* Hook. f. from *Morinda* L., therefore two new combinations in *Appunia* from the Guayana Shield are necessary. The phylogenetic studies of Dessein (2003), Dessein et al. (2006a), Groeninckx et al. (2009a, 2009b), and Lens et al. (2009) confirm the wide delimitation of the genus *Spermacoce* L. (incl. *Borreria* G. Mey.), as already treated by Adams (in Burger & Taylor, 1993), Boom & Delprete (2002), Delprete et al. (2005), Delprete & Cortés ("2006" 2007), Delprete (2007), De Vré (2000), Dessein et al. (2003, 2006a), and Vaes et al. (2006). A recent re-delimitation of *Chiococca nitida* Benth. was published by Delprete ("2004" [2005]), and the necessary synonymies are listed below. Additional synonyms and rearrangements here presented are based on direct observations and ongoing revisionary and floristic treatments by the present author.

Appunia aurantiaca (K. Krause) Sandwith—**GU?**
Appunia brachycalyx (Bremek.) Steyerm.—**GU, SU, FG**
Appunia calycina (Benth.) Sandwith—**GU**
Appunia debilis Sandwith—**GU**
Appunia longipedunculata (Steyerm.) Delprete, **comb. nov.—AM**

Note: Basionym: *Morinda longipedunculata* Steyerm., Ann. Missouri Bot. Gard. 75:340. 1988; Type: VENEZUELA: Sierra de la Neblina, 22–23 Jul 1984, *Davidse 27651* (holotype: MO, isotype: VEN).

Appunia peduncularis (Kunth) Delprete, **comb. nov.—AM, GU**

Note: Basionym: *Morinda peduncularis* Kunth in Humb. & Bonpl, Nov. Gen. Sp. 3(12, quarto): 380. 1819. Type: VENEZUELA: Río Orinoco, San Borja, *Humboldt & Bonpland s.n.* (holotype: P-Bonpl.).

Appunia surinamensis (Bremek.) Steyerm.—**SU**
Appunia tenuiflora Hook. f.—**AM, BO, GU, SU, FG**
Appunia venezuelensis Steyerm.—**BO**
Borreria alata (Aubl.) DC.—should be deleted
Borreria bolivarensis Steyerm.—should be deleted
Borreria capitata (Ruiz & Pav.) DC.—should be deleted
Borreria capitata var. *capitata*—should be deleted
Borreria capitata var. *suaveolens* (G. Mey.) Steyerm.—should be deleted
Borreria capitata var. *tenella* (Kunth) Steyerm.—should be deleted
Borreria cataractarum Steyerm.—should be deleted
Borreria confertifolia Steyerm.—should be deleted
Borreria densiflora DC.—should be deleted
Borreria hispida Spruce ex K. Schum.—should be deleted
Borreria intricata Steyerm.—should be deleted
Borreria jangouxii Steyerm.—should be deleted
Borreria latifolia (Aubl.) K. Schum.—should be deleted
Borreria macrocephala Standl. & Steyerm.—should be deleted
Borreria ovalifolia M. Martens & Galeotti—should be deleted
Borreria prostrata (Aubl.) Miq.—should be deleted
Borreria pygmaea Spruce ex K. Schum.—should be deleted
Borreria remota (Lam.) Bacigalupo & E.L. Cabral—should be deleted
Borreria repens DC.—should be deleted
Borreria verticillata (L.) G. Mey.—should be deleted
Borreria wurdackii Steyerm.—should be deleted
Borreria xanthophylla Bremek.—should be deleted
Calycophyllum intonsum Steyerm.—**GU**
Calycophyllum merumense Steyerm.—**GU**
Calycophyllum spectabile Steyerm.—**GU**
Carapichea guianensis Aubl.—**SU, FG**
Carapichea ligularis (Rudge) Delprete—**GU, SU, FG**
Chimarrhis cymosa Jacq.—should be deleted [endemic to Lesser Antilles; cf. Delprete, 1999, Flora Neotropica 77:152–155).
Chiococca multipedunculata Steyerm.—should be deleted
Chiococca nitida var. *amazonica* Muell. Arg.—should be deleted
Chiococca nitida var. *chimantensis* Steyerm.—should be deleted
Chiococca nitida var. *nitida*.—should be deleted
Coussarea longilaciniata Delprete—**GU**
Coussarea spicata Delprete—**FG**
Diodella apiculata (Willd. ex Roem. & Schult.) Delprete—**AM, BO, GU, SU, FG**

Note: Delprete 2004. in A. Reis, Fl. Ilutrada Catar., Rubiaceas I:169.

Diodella radula (Willd. ex Roem. & Schult.) Delprete—**BO**

Note: Delprete 2004. in A. Reis, Fl. Ilutrada Catar., Rubiaceas I:174.

Diodella sarmentosa (Sw.) Bacigalupo & E.L. Cabral ex Borhidi—**AM, BO, DA, GU, SU, FG**

Note: Borhidi. 2006. Rubiáceas de México. 186.

Diodia apiculata (Willd. ex Roem. & Schult.) K. Schum.—should be deleted

Diodia hyssopifolia (Willd. ex Roem. & Schult.) Cham. & Schltdl.—should be deleted

Diodia multiflora DC.—should be deleted

Diodia ocymifolia (Willd. ex Roem. & Schult.) Bremek.—should be deleted

Diodia pulchristipula Bremek.—should be deleted

Diodia radula (Willd. & Hoffmanns. ex Roem. & Schult.) Cham. & Schltdl.—should be deleted

Diodia radula subsp. *venezuelensis* Steyerm.—should be deleted

Diodia sarmentosa Sw.—should be deleted

Diodia spicata Miq.—should be deleted

Diodia teres Walter—should be deleted

Faramea pedunculata (Bremek.) Delprete—**GU, FG**

Faramea sessiliflora Aubl. var. *pedunculata* Bremek.—should be deleted

Faramea sessiliflora var. *sessiliflora*—should be deleted

Hoffmannia megistophylla Standl.—should be deleted

Ibetralia surinamensis Bremek.—should be deleted

Kutchubaea surinamensis (Bremek.) C.H. Perss.—**SU, FG**

Note: C.H. Perss. 2005. Revista Biol. Neotrop. 2:67.

Morinda brachycalyx (Bremek.) Steyerm.—should be deleted

Morinda calycina (Benth.) Steyerm.—should be deleted

Morinda debilis (Sandwith) Steyerm.—should be deleted

Morinda longiloba (Steyerm.) Steyerm.—should be deleted

Morinda longipedunculata Steyerm. [Sierra de la Neblina]—should be deleted

Morinda peduncularis Kunth—should be deleted

Morinda sparsiflora (Steyerm.) Steyerm.—should be deleted

Morinda surinamensis (Bremek.) Steyerm.—should be deleted

Morinda tenuiflora (Benth.) Steyerm.—should be deleted

Morinda tenuiflora var. *leiophylla* (Steyerm.) Steyerm.—should be deleted

Palicourea lemoniana C.M. Taylor—**AM**

Patima guianensis Aubl.—add **SU**

Psychotria ligularis (Rudge) Steyerm.—should be deleted

Psychotria ligularis var. *ligularis*—should be deleted

Semaphyllanthe intonsa (Steyerm.) L. Andersson—should be deleted

Semaphyllanthe merumensis (Steyerm.) L. Andersson—should be deleted

Semaphyllanthe spectabilis (Steyerm.) L. Andersson—should be deleted

Spermacoce alata Aubl.—**AM, GU, SU, FG**

Spermacoce bolivarensis (Steyerm.) Govaerts—**BO**

Spermacoce capitata Ruiz & Pav.—**AM, BO, GU, SU, FG**

Spermacoce cataractarum (Steyerm.) Govaerts—**BO, GU**

Spermacoce confertifolia (Steyerm.) Govaerts—**AM, BO, GU**

Spermacoce densiflora (DC.) Liogier—**AM, BO, GU**

Spermacoce exilis (L.O. Williams) C.D. Adams—**AM, BO, DA, GU, SU, FG**

Spermacoce hexangularis Aubl.—**FG**

Spermacoce hyssopifolia Willd. ex Roem. & Schult. (1818); non Kunth (1819)—**AM, BO, DA, GU, SU, FG**

Spermacoce intricata (Steyerm.) Govaerts—**AM**

Spermacoce jangouxii (Steyerm.) Govaerts—**AM**

Spermacoce latifolia Aubl.—**AM, BO, DA, GU, SU, FG**

Spermacoce macrocephala (Standl. & Steyerm.) Govaerts—**AM**

Spermacoce multiflora (DC.) Delprete—**DA**

Spermacoce neohispida Govaerts—**AM, BO, GU, SU, FG**

Spermacoce ocymifolia Willd. ex Roem. & Schult.—**AM, BO, DA, GU, SU, FG**

Spermacoce ovalifolia (M. Martens & Galeotti) Hemsl.—**GU**

Spermacoce prostrata Aubl.—**AM, BO, DA, GU, SU, FG**

Spermacoce pulchristipula (Bremek.) Delprete—**GU, SU**

Spermacoce remota Lam.—**AM, BO, GU, SU, FG**

Spermacoce spicata (Miq.) Delprete—**AM, GU, SU, FG**

Spermacoce spruceana Kuntze—**AM, BO**

Spermacoce suaveolens (G. Mey.) Kuntze—**GU, SU**

Spermacoce tenella Kunth—**AM, BO, GU, SU, FG**

Spermacoce verticillata L.—**AM, BO, DA, GU, SU, FG**

Spermacoce wurdackii (Steyerm.) Govaerts—**AM**

Spermacoce xanthophylla (Bremek.) Govaerts—**SU**

Synonyms and misidentifications

Alibertia surinamensis (Bremek.) Steyerm. = *Kutchubaea surinamensis* (Bremek.) C.H. Perss.

Appunia longiloba Steyerm. = *Appunia tenuiflora* Hook. f.

Appunia sparsiflora Steyerm. = *Appunia tenuiflora* Hook. f.

Appunia tenuiflora var. *leiophylla* Steyerm. = *Appunia tenuiflora* Hook. f.

Bellynkxia brachycalyx Bremek. = *Appunia brachycalyx* (Bremek.) Steyerm.

Bellynkxia calycina (Benth.) Bremek. = *Appunia calycina* (Benth.) Sandwith

Bellynkxia surinamensis Bremek. = *Appunia surinamensis* (Bremek.) Steyerm.

Bigelovia sphaerica DC. = *Spermacoce remota* Lam.

Bigelowia verticillata (L.) Spreng. = *Spermacoce verticillata* L.

Borreria alata (Aubl.) DC. = *Spermacoce alata* Aubl.

Borreria alternans Bello = *Spermacoce ocymifolia* Willd. ex Roem. & Schult.

Borreria asperula DC. = *Spermacoce ocymifolia* Willd. ex Roem. & Schult.

Borreria assurgens (Ruiz & Pav.) Griseb. = *Spermacoce remota* Lam.

Borreria bolivarensis Steyerm. = *Spermacoce bolivarensis* (Steyerm.) Govaerts

Borreria capitata (Ruiz & Pav.) DC. = *Spermacoce capitata* Ruiz & Pav.

Borreria capitata var. *capitata* f. *ferruginea* (A. St.-Hil.) Steyerm. = *Spermacoce capitata* Ruiz & Pav.

Borreria capitata var. *capitata* f. *glabra* Steyerm. = *Spermacoce capitata* Ruiz & Pav.

Borreria capitata var. *suaveolens* (G. Mey.) Steyerm. = *Spermacoce suaveolens* (G. Mey.) Kuntze

Borreria capitata var. *tenella* (Kunth) Steyerm. = *Spermacoce tenella* Kunth

Borreria cataractarum Steyerm. = *Spermacoce cataractarum* (Steyerm.) Govaerts

Borreria confertifolia Steyerm. = *Spermacoce confertifolia* (Steyerm.) Govaerts

Borreria densiflora DC. = *Spermacoce densiflora* (DC.) Liogier

Borreria elongata DC. = *Spermacoce capitata* Ruiz & Pav.

Borreria ferruginea (A. St.-Hil.) DC. = *Spermacoce capitata* Ruiz & Pav.

Borreria fockeana Miq. = *Spermacoce latifolia* Aubl.

Borreria hispida Spruce ex K. Schum. = *Spermacoce neohispida* Govaerts

Borreria intricata Steyerm. = *Spermacoce intricata* (Steyerm.) Govaerts

Borreria jangouxii Steyerm. = *Spermacoce jangouxii* (Steyerm.) Govaerts

Borreria kappleriana Miq. = *Spermacoce capitata* Ruiz & Pav.

Borreria laevis (Lam.) Griseb. = *Spermacoce remota* Lam.

Borreria latifolia (Aubl.) K. Schum. = *Spermacoce latifolia* Aubl.

Borreria latifolia var. *fockeana* (Miq.) Bremek. = *Spermacoce latifolia* Aubl.

Borreria linifolia DC. = *Spermacoce remota* Lam.

Borreria linoides DC. = *Spermacoce tenella* Kunth

Borreria lutescens DC. = *Spermacoce capitata* Ruiz & Pav.

Borreria macrocephala Standl. & Steyerm. = *Spermacoce macrocephala* (Standl. & Steyerm.) Govaerts

Borreria minima DC. = *Spermacoce verticillata* L.

Borreria multiflora (DC.) Bacigalupo & Cabral = *Spermacoce multiflora* (DC.) Delprete

Borreria nectarifera Rusby = *Spermacoce capitata* Ruiz & Pav.

Borreria ocymifolia (Willd. ex Roem. & Schult.) Bacigalupo & E.L. Cabral = *Spermacoce ocymifolia* Willd. ex Roem. & Schult.

Borreria oligodonta Steyerm. = *Spermacoce verticillata* L.

Borreria ovalifolia M. Martens & Galeotti = *Spermacoce ovalifolia* (M. Martens & Galeotti) Hemsl.

Borreria penicillata Miq. = *Spermacoce latifolia* Aubl.

Borreria perrottetii DC. = *Spermacoce latifolia* Aubl.

Borreria podocephala DC. = *Spermacoce verticillata* L.

Borreria pulchristipula (Bremek.) Bacigalupo & Cabral = *Spermacoce pulchristipula* (Bremek.) Delprete

Borreria pygmaea Spruce ex K. Schum. = *Spermacoce spruceana* Kuntze

Borreria remota (Lam.) Bacigalupo & E.L. Cabral = *Spermacoce remota* Lam.

Borreria repens DC. = *Spermacoce exilis* (L.O. Williams) C.D. Adams

Borreria spicata (Miq.) Bacigalupo & Cabral = *Spermacoce spicata* (Miq.) Delprete

Borreria splitgerberi Bremek. = *Spermacoce latifolia* Aubl.

Borreria stricta G. Mey. = *Spermacoce verticillata* L.

Borreria suaveolens G. Mey. = *Spermacoce suaveolens* (G. Mey.) Kuntze

Borreria suaveolens var. *linoides* (DC.) Standl. = *Spermacoce suaveolens* (G. Mey.) Kuntze

Borreria suaveolens G. Mey. var. *platyphylla* (K. Schum.) Standl. = *Spermacoce tenella* Kunth

Borreria tenella (Kunth) Cham. & Schltdl. = *Spermacoce tenella* Kunth

Borreria tenella var. *angustifolia* DC. = *Spermacoce tenella* Kunth

Borreria tenella var. *genuina* K. Schum. = *Spermacoce tenella* Kunth

Borreria tenella var. *linoides* K. Schum. = *Spermacoce tenella* Kunth

Borreria tenella var. *platyphylla* K. Schum. = *Spermacoce tenella* Kunth

Borreria tenella var. *suaveolens* (G. Mey.) K. Schum. = *Spermacoce suaveolens* (G. Mey.) Kuntze

Borreria tetraptera Miq. = *Spermacoce latifolia* Aubl.

Borreria trichantha Miq. = *Spermacoce ocymifolia* Willd. ex Roem. & Schult.

Borreria verticillata (L.) G. Mey. = *Spermacoce verticillata* L.

Borreria virgata Cham. & Schltdl. = *Spermacoce ocymifolia* Willd. ex Roem. & Schult.

Borreria wurdackii Steyerm. = *Spermacoce wurdackii* (Steyerm.) Govaerts

Borreria xanthophylla Bremek. = *Spermacoce xanthophylla* (Bremek.) Govaerts

Callicocca guianensis (Aubl.) Gmel. = *Carapichea guianensis* Aubl.

Carapichea aubletii DC. = *Carapichea guianensis* Aubl.

Cephaelis guianensis (Aubl.) Standl. = *Carapichea guianensis* Aubl.

Coffea calycina Benth. = *Appunia calycina* (Benth.) Sandwith

Chiococca cordata = *Chiococca nitida* Benth.

Chiococca erubescens Wernham = *Chiococca nitida* Benth.

Chiococca multipedunculata Steyerm. = *Chiococca nitida* Benth.

Chiococca nitida var. *amazonica* Muell. Arg. = *Chiococca nitida* Benth.

Chiococca nitida var. *amazonica* f. *cordata* (Cowan) Steyerm. = *Chiococca nitida* Benth.

Chiococca nitida var. *chimantensis* Steyerm. = *Chiococca nitida* Benth.

Coffea tenuiflora Benth. = *Appunia tenuiflora* Hook. f.

Cordiera surinamensis Miq. ex Bremek. = *Appunia surinamensis* (Bremek.) Steyerm.

Dasycephala spicata (Miq.) Hook. f. = *Spermacoce spicata* (Miq.) Delprete

Diodia apiculata (Willd. ex Roem. & Schult.) K. Schum. = *Diodella apiculata* (Willd. ex Roem. & Schult.) Delprete

Diodia articulata Pohl ex DC. = *Spermacoce hyssopifolia* Willd. ex Roem. & Schult.

Diodia hyssopifolia (Willd. ex Roem. & Schult.) Cham. & Schltdl. = *Spermacoce hyssopifolia* Willd. ex Roem. & Schult.

Diodia hyssopifolia var. *articulata* (Pohl ex DC.) Steyerm. = *Spermacoce hyssopifolia* Willd. ex Roem. & Schult.

Diodia hyssopifolia var. *hyssopifolia* f. *psiloclada* Steyerm. = *Spermacoce hyssopifolia* Willd. ex Roem. & Schult.

Diodia hyssopifolia var. *linearis* (Willd. ex Roem. & Schult.) Steyerm. = *Spermacoce hyssopifolia* Willd. ex Roem. & Schult.

Diodia hyssopifolia var. *linearis* f. *glabriuscula* Steyerm. = *Spermacoce hyssopifolia* Willd. ex Roem. & Schult.

Diodia multiflora DC. = *Spermacoce multiflora* (DC.) Delprete

Diodia ocymifolia (Willd. ex Roem. & Schult.) Bremek. = *Spermacoce ocymifolia* Willd. ex Roem. & Schult.

Diodia pulchristipula Bremek. = *Spermacoce pulchristipula* (Bremek.) Delprete

Diodia radula (Willd. & Hoffmanns. ex Roem. & Schult.) Cham. & Schltdl. = *Diodella radula* (Willd. ex Roem. & Schult.) Delprete

Diodia radula subsp. *venezuelensis* Steyerm. = *Diodella radula* (Willd. ex Roem. & Schult.) Delprete

Diodia sarmentosa Sw. = *Diodella sarmentosa* (Sw.) Bacigalupo & E.L. Cabral ex Borhidi

Diodia spicata Miq. = *Spermacoce spicata* (Miq.) Delprete

Diodia surinamensis Miq. = *Spermacoce hyssopifolia* Willd. ex Roem. & Schult.

Diodia teres Walter = *Diodella teres* (Walter) Small

Faramea sessiliflora Aubl. var. *pedunculata* Bremek. = *Faramea pedunculata* (Bremek.) Delprete

Hemidiodia ocymifolia (Willd. ex Roem. & Schult.) K. Schum. (as "ocimifolia" [ort. var.]) = *Spermacoce ocymifolia* Willd. ex Roem. & Schult.

Hoffmannia megistophylla Standl. = *Patima guianensis* Aubl.

Ibetralia surinamensis Bremek. = *Kutchubaea surinamensis* (Bremek.) C.H. Perss.

Morinda aurantiaca (K. Krause) Steyerm. = *Appunia aurantiaca* (K. Krause) Sandwith

Morinda brachycalyx (Bremek.) Steyerm. = *Appunia brachycalyx* (Bremek.) Steyerm.

Morinda calycina (Benth.) Steyerm. = *Appunia calycina* (Benth.) Sandwith

Morinda debilis (Sandwith) Steyerm. = *Appunia debilis* Sandwith

Morinda longiloba (Steyerm.) Steyerm. = *Appunia tenuiflora* Hook. f.

Morinda longipedunculata Steyerm. = *Appunia longipedunculata* (Steyerm.) Delprete

Morinda peduncularis Kunth = *Appunia peduncularis* (Kunth) Delprete

Morinda sparsiflora (Steyerm.) Steyerm. = *Appunia tenuiflora* Hook. f.

Morinda surinamensis (Bremek.) Steyerm. = *Appunia surinamensis* (Bremek.) Steyerm.

Morinda tenuiflora (Benth.) Steyerm. = *Appunia tenuiflora* Hook. f.

Morinda tenuiflora var. *leiophylla* (Steyerm.) Steyerm. = *Appunia tenuiflora* Hook. f.

Morinda venezuelensis (Steyerm.) Steyerm. = *Appunia venezuelensis* Steyerm.

Psychotria carapichea (Steyerm.) Delprete = *Carapichea guianensis* Aubl.

Psychotria galbaoensis Steyerm. = *Carapichea guianensis* Aubl.

Psychotria ligularis (Rudge) Steyerm. = *Carapichea ligularis* (Rudge) Delprete

Psychotria ligularis var. *carapichea* Steyerm. = *Carapichea guianensis* Aubl.

Schradera ligularis Rudge = *Carapichea ligularis* (Rudge) Delprete

Semaphyllanthe intonsa (Steyerm.) L. Andersson = *Calycophyllum intonsum* Steyerm.

Semaphyllanthe merumensis (Steyerm.) L. Andersson = *Calycophyllum merumense* Steyerm.

Semaphyllanthe spectabilis (Steyerm.) L. Andersson = *Calycophyllum spectabile* Steyerm.

Spermacoce assurgens Ruiz & Pav. = *Spermacoce remota* Lam.

Spermacoce aturensis Kunth = *Spermacoce hyssopifolia* Willd. ex Roem. & Schult.

Spermacoce brasiliensis Spreng. = *Spermacoce tenella* Kunth

Spermacoce capitellata Willd. ex Roem. & Schult. = *Spermacoce remota* Lam.

Spermacoce coerulea Pohl ex DC. = *Spermacoce ocymifolia* Willd. ex Roem. & Schult.

Spermacoce coerulescens Aubl. = *Spermacoce latifolia* Aubl.

Spermacoce ernstii R. Fosberg & D. Powell = *Spermacoce ovalifolia* (M. Martens & Galeotti) Hemsl.

Spermacoce ferruginea A. St.-Hil = *Spermacoce capitata* Ruiz & Pav.

Spermacoce guianensis Bremek. = *Spermacoce remota* Lam.

Spermacoce laevis Lam. = *Spermacoce remota* Lam.

Spermacoce linearis Willd. ex Roem. & Schult. = *Spermacoce hyssopifolia* Willd. ex Roem. & Schult.

Spermacoce linoides Pohl ex DC. = *Spermacoce suaveolens* (G. Mey.) Kuntze

Spermacoce longifolia Aubl. = *Mitracarpus* sp. ?

Spermacoce longifolia f. *glabrata* Miq. = *Spermacoce ocymifolia* Willd. ex Roem. & Schult.

Spermacoce oligodonta (Steyerm.) Govaerts = *Spermacoce verticillata* L.

Spermacoce orinocensis Roem. & Schult. = *Spermacoce capitata* Ruiz & Pav.

Spermacoce portoriccensis Balb. ex DC. = *Spermacoce ocymifolia* Willd. ex Roem. & Schult.

Spermacoce pringlei S. Watson = *Spermacoce ovalifolia* (M. Martens & Galeotti) Hemsl.

Spermacoce radicans Aubl. = *Spermacoce prostrata* Aubl.

Spermacoce suaveolens f. *glabra* Kuntze = *Spermacoce suaveolens* (G. Mey.) Kuntze

Spermacoce suaveolens f. *pubescens* Kuntze = *Spermacoce suaveolens* (G. Mey.) Kuntze

Spermacoce suaveolens var. *tenella* (Kunth) Kuntze = *Spermacoce tenella* Kunth

Tardavel tenella (Kunth) Standl. = *Spermacoce tenella* Kunth

Uragoga guianensis (Aubl.) Pulle = *Carapichea guianensis* Aubl.

References

Delete: Clark, H., R. Liesner, P.E. Berry, A. Fernández, G. Aymard, and P. Aquirino. 2000. Catálogo Anotado de la Flora del Área de San Carlos de Río Negro, Venezuela. Sci. Guaianae 11:101–316.

Boom, B.M. and P.G. Delprete. Rubiaceae. 2002. In: A. Mori et al., eds. Guide to the vascular plants of central French Guiana. Part 2. Dicotyledons. Mem. New York Bot. Gard. 76:606–649.

BURGER, W. AND C.M. TAYLOR. 1993. Family 202 Rubiaceae. In: W. Burger, ed. Flora Costaricensis. Fieldiana, Bot., n. s. 33:1–333.

DELPRETE, P.G. 2003. *Carapichea guianensis*: the correct name for *Psychotria carapichea* (Rubiaceae), with a correction on the authority of *P. carapichea*, and a new combination in *Carapichea*. Brittonia 55:88–89.

DELPRETE, P.G. "2004" [2005]. *Chiococca plowmanii*, a new species endemic to the coastal vegetation of northeastern Brazil, and a realignment of *Chiococca nitida* (Rubiaceae, Chiococceae). Rev. Biol. Neotrop. 1(1–2):4–10.

DELPRETE, P. 2006. Two new species of *Coussarea* and a new combination in *Faramea* (Rubiaceae, Coussareeae) from the Guianas. Blumea 51:355–364.

DELPRETE, P.G. 2007. New combinations and new synonymies in the genus *Spermacoce* (Rubiaceae) for the Flora of Goiás and Tocantins (Brazil) and the Flora of the Guianas. J. Bot. Res. Inst. Texas 1:1023–1030.

DELPRETE, P.G. AND R. CORTÉS-B. "2006" [Jun 2007]. A synopsis of the Rubiaceae of the states of Mato Grosso and Mato Grosso do Sul, Brazil, with a key to genera, and a preliminary species list. Rev. Biol. Neotrop. 3:13–96.

DELPRETE, P.G., L.B. SMITH, AND R.B. KLEIN. 2005. Rubiáceas, Volume 2 - Gêneros de G-Z: 20. *Gardenia* até 46. *Tocoyena* (com observações ecologicas por R. Klein, A. Reis, and O. Iza), pp. 345–843. In: A. Reis, ed. Flora Ilustrada Catarinense. Herbário Barbosa Rodrigues, Itajaí, Santa Catarina, Brazil.

DE VRÉ, P. 2000. Pollenmorfologische studie van de Spermacoceae (Rubioideae - Rubiaceae). Undergraduate Thesis. 135 p. Katholieke Universiteit Leuven, Leuven, Belgium.

DESSEIN, S. 2003. Systematic studies in the Spermacoceae (Rubiaceae). Doctoral Thesis. 403 p. Katholieke Universiteit Leuven, Leuven, Belgium.

DESSEIN, S., R. HARWOOD, I. GROENINCKS, AND E. ROBBRECHT. 2006a. Diversity among Australian *Spermacoce* species. Third International Rubiaceae Conference - Programme & Abstracts. Scr. Bot. Belgica 40:30.

DESSEIN, S., E. ROBBRECHT, AND E. SMETS. 2006b. A new hereophyllous *Spermacoce* species (Rubiaceae) from the Marungu Highlands, Democratic Republic of the Congo. Novon 16:231–234.

GROENINCKS, I., P. DE BLOCK, F. Rakotonasolo, E. SMETS, AND S. DESSEIN. 2009a. Rediscovery of Malagasy *Lathraeocarpa* allows determination of its taxonomic position within Rubiaceae. Taxon 58:209–226.

GROENINCKS, I., S. DESSEIN, H. OCHOTERENA, C. PERSSON, T.J. MOTLEY, J. KAREHED, B. BREMER, AND E. SMETS. 2009b. Phylogeny of the herbaceous tribe Spermacoceae (Rubiaceae) based on plastid DNA data. Ann. Missouri Bot. Gard. 96:109–132.

LENS, F., I. GROENINCKX, E. SMETS, AND S. DESSEIN. 2009. Woodiness within the Spermacoceae-Knoxieae alliance (Rubiaceae): retention of the basal woody condition in Rubiaceae or recent innovation? Ann. Bot. 103:1049–1064.

RAZAFIMANDIMBISON, S.G., T.D. MCDOWELL, D.A. HALFORD, AND B. BREMER. 2009. Molecular phylogenetics and generic assessment in the tribe Morindae (Rubiaceae-Rubioideae): how to circumscribe *Morinda* L. to be monophyletic? Molec. Phylgen. Evol. 52:879–886.

TAYLOR, C.M. 2006. Rubiacearum Americanarum Magna Hama Pars XIX. New species of *Palicourea* (Psychotrieae) from Ecuador, Peru, and Venezuela. Brittonia 58:156–169.

VAES, E., A. VRIJDAGHS, E. SMETS, AND S. DESSEIN. 2006. Elaborate petals in Australian *Spermacoce* (Rubiaceae) species: morphology, ontogeny and function. Ann. Bot. 98:1167–1178.

RUTACEAE (p. 507–510)

Neoraputia paraensis (Ducke) Emmerich—author should read "(Ducke) Kallunki"

Reference

KALLUNKI, J.A. 2009. Validation of *Neoraputia* (Galipeae, Rutaceae) and description of two new species from Eastern Brazil. Brittonia 6:28–34. Author as "Emmerich ex Kallunki"

SABIACEAE (p. 510–511)

Ophiocaryon barnebyanum Aymard & Daly—**AM**

Reference

AYMARD, G.A. AND D.C. DALY. 2006. Two new species of *Ophiocaryon* (Sabiaceae) from South America. Brittonia 58:270–276.

VIOLACEAE (p. 547–549)

Hekkingia bordenavei H.E. Ballard & Munzinger—**FG**

Reference

MUNZINGER, J.K. AND H.E. BALLARD. 2003. *Hekkingia* (Violaceae), a new arborescent violet genus from French Guiana, with a key to genera in the family. Syst. Bot. 28:345–351.

VITACEAE (p. 552–553)

Cissus descoingsii J.A. Lombardi—should be deleted
Cissus duarteana Cambess.—should be deleted
Cissus guyanensis Descoings—add **BO, GU**
Cissus kawensis Descoings—**FG**
Cissus subrhomboidea (Baker) Planch.—add **FG**

Synonyms and misidentifications

Cissus descoingsii J.A. Lombardi (invalid and illegitimate) = *Cissus guyanensis* Descoings
Cissus duarteana Cambess. [misidentification for *Cissus subrhomboidea* (Baker) Planch.]

Reference

Descoings, B. 2008. Contribution à l'étude des Vitacées d'Amérique tropicale. III—*Cissus spinosa* Cambess., *C. subrhomboidea* (Baker) Planchon, *C. flavens* et *C. kawensis*, spp. nov. J. Bot. Soc. Bot. France 44:3–17.

VOCHYSIACEAE (p. 553–555)

Qualea marioniae Marcano-Berti (as "*marionii*")—**GU**

Reference

Marcano-Berti, L. 2002. Studies on the flora of the Guianas n° 101. New Vochysiaceae: *Qualea johannabakkeri* and *Qualea marionii*. Acta Bot. Venez. 25:111–118.

ACKNOWLEDGMENTS

I am grateful to Vicki Funk who encouraged me to publish this update. I appreciate the input from the reviewers, Howard L. Clark (Quito, Ecuador, †27 Aug 2009, cf. p. 996) and Paul Hiepko (B). I am thankful for the help provided at the Smithsonian Institution by the Department of Botany librarian Robin Everly and database specialist Sara Alexander; their patience through multiple requests was endless. This is number 149 in the Smithsonian's Biological Diversity of the Guiana Shield Program publication series.

REFERENCES

Berry, P.E., K. Yatskievych, and B.K. Holst (eds.). 1995–2005. Flora of the Venezuelan Guayana, 9 volumes. Missouri Botanical Garden, Saint Louis.

Funk, V., T. Hollowell, P.E. Berry, C. Kelloff, and S.N. Alexander. 2007. Checklist of the plants of the Guiana Shield (Venezuela: Amazonas, Bolivar, Delta Amacuro; Guyana, Surinam, French Guiana). Contr. U.S. Natl. Herb. 55:1–584.

Görts-van Rijn, A.R.A. and M. Jansen-Jacobs (eds.). 1985–2008. Flora of the Guianas. Ser. A, fasc. 1–26 (in progress); Ser. B, fasc. 3, 4 & 6 (in progress). Koeltz, Koenigstein and Kew Royal Botanical Garden, Richmond.

Mori, S.A., G. Cremers, C.A. Gracie, J.-J. de Granville, M. Hoff, and J.D. Mitchell (eds.). 1997. Guide to the plants of Central French Guiana. Part 1. Pteridophytes, Gymnosperms, and Monocotyledons. Mem. New York Bot. Gard. 76(1):1–422.

Mori, S.A., G. Cremers, C.A. Gracie, J.-J. de Granville, S.V. Head, M. Hoff, and J.D. Mitchell (eds.). 2002. Guide to the plants of Central French Guiana. Part 1. Dicotyledons. Mem. New York Bot. Gard. 76(2):1–776.

NOTES ON THE TAXONOMIC HISTORY, REDISCOVERY AND CONSERVATION STATUS OF TWO ENDANGERED SPECIES OF *CEROPEGIA* (ASCLEPIADACEAE) FROM SIKKIM HIMALAYA

D.C. Nautiyal, S.K. Sharma, and M.K. Pandit[1]

Centre for Interdisciplinary Studies of Mountain & Hill Environment
Academic Research Centre Building
University of Delhi, Delhi - 110007, INDIA

ABSTRACT

Ceropegia hookeri C.B. Clarke ex Hook.f. and *C. lucida* Wall. have been reported to be endangered or possibly extinct from India. This contribution marks rediscovery of the *C. lucida* from Sikkim after a gap of nearly 133 years. We could locate a single population of *C. hookeri* comprising about 8–10 individuals near Lachen village. These individuals showed a patchy distribution in about one square kilometer area. Likewise, we observed only two populations of *C. lucida* restricted to Lachung area of North Sikkim. Both these species have low population sizes and are faced with degradation and loss of habitat. Our studies confirm the critically endangered status of these species and we report that a large number of their populations have already gone extinct from the wild. In this paper we discuss collection history, taxonomy, habitat characteristics and conservation status of these two species in view of the various threats to their survival in nature and suggest urgent ex situ and in situ conservation measures for these species.

Key Words: *Ceropegia hookeri*, *C. lucida*, endangered, habitat degradation, geographic range shift, Sikkim Himalaya

RESUMEN

Ceropegia hookeri C.B. Clarke ex Hook.f. y *C. lucida* Wall. se han citado como amenazadas o posiblemente extintas de la India. Esta contribución marca el redescubrimiento de *C. lucida* de Sikkim después de unos 133 años. Pudimos localizar una sola población de *C. hookeri* con unos 8–10 individuos cerca del pueblo de Lachen. Estos individuos mostraban una distribución irregular en un área de cerca de un kilómetro cuadrado. Así mismo, observamos sólo dos poblaciones de *C. lucida* restringidas al área de North Sikkim. Ambas especies tienen tamaños de población pequeños y se enfrentan a degradación y pérdida de hábitat. Nuestros estudios confirman el estatus críticamente amenazado de estas especies y confirmamos que un gran número de miembros de sus poblaciones ya se han extinguido en la naturaleza. En este artículo discutimos la historia de las colecciones, taxonomía, hábitat características y estado de conservación de estas dos especies a la vista de las varias amenazas a su supervivencia en la naturaleza y sugerimos medidas de conservación urgente ex situ e in situ para estas especies.

INTRODUCTION

Ceropegia L. is represented by about 44–45 species, 1 subspecies and 2–3 varieties in India, of which 28 species are endemic (Ansari 1984; Jagtap & Singh 1999). *Ceropegia* has greater representation in Peninsular India with 23 species (Kavade & Diwakar 2004). There are 9 species of this genus known from Himalaya of which five are present in Eastern Himalaya. Sikkim harbors 3 out of 5 known species from the Eastern Himalayan region. East Himalayan species of *Ceropegia* have been studied by Wallich (1831), King (1874), Hooker (1885), Kanjilal and Bor (1939) and Hara et al. (1982). However, based on our information from Indian herbaria as well as published literature, these species are highly underrepresented in collections (Nayar & Sastry 1988). *Ceropegia* is represented by a disproportionately higher number of endangered species with at least 12, out of 44 species, reported to be endangered or possibly extinct from the Indian subcontinent.

The *Red Data Book of India* (Nayar & Sastry 1987–90) was the first serious attempt at making authentic assessment of the status of Indian plants. This publication paved way for further intensive studies, which unfortunately could not be followed up by action. Nearly 158 Himalayan plant species were reported to face various degrees of threat. In Sikkim, Eastern Himalaya, more than 40 species of higher plants are reported to be facing survival risks. Being a rich zone of biodiversity, it is crucial to understand and reassess the

---

[1] **Corresponding author, e-mail: mkpandit@cismhe.org**

J. Bot. Res. Inst. Texas 3(2): 815 – 822. 2009

status of various endangered/rare species in Sikkim. The habitats in Sikkim are under severe pressure from increasing human population, expanding agriculture, and large-scale developmental activities. Recent studies have shown that a number of species are likely to be consigned to extinction in Himalaya as a result of unprecedented deforestation and land use changes (Pandit et al. 2007). A number of proposed hydro-power projects along Teesta River and its tributaries pose a serious threat to habitats which may further exacerbate species population losses in these habitats (CISMHE 2007). This contribution is a part of the studies aimed at reviewing the status of endangered species in Sikkim. In this paper we have attempted to assess the magnitude of loss of species populations of *Ceropegia* and appropriate steps for their effective conservation are indicated.

MATERIAL AND METHODS

During plant explorations carried out during 2002 to 2006 in Sikkim, covering various habitats from subtropical to alpine zones, we collected a few specimens of *Ceropegia* L. from North Sikkim (Fig. 1). After a thorough screening and consultation of herbaria at Central National Herbarium (CAL), Kolkata and Botanical Survey of India, Sikkim Himalaya Circle, Gangtok (SHC), followed by review of literature, these species were identified as *Ceropegia hookeri* C.B. Clarke ex Hook.f. and *C. lucida* Wall. The voucher specimens are deposited at the Herbarium, CISMHE, University of Delhi, Delhi, India. During the survey we also recorded the habitat conditions, associates of these species as well as biotic and abiotic pressures so as to asses various threats to their populations.

RESULTS

The taxonomic description of *Ceropegia hookeri* and *C. lucida* is given below. Line diagrams of the collected specimens are given in Figures 2 and 3, respectively. The photographs of the flowers of *C. hookeri* and *C. lucida* in Figures 4 and 5, respectively.

Ceropegia hookeri C.B. Clarke ex Hook.f., Fl. Brit. India 4:73. 1885; Ansari, Fasc. Fl. India 16:17. 1984.

Erect or decumbent twining, hairy herbs, with a strong tuberous rootstock. Stem very slender, 20–60 cm long and 0.2–0.3 cm wide, slightly pubescent. Leaves membranous, ovate, acuminate, 2–4 cm long and 0.5–3 cm wide, hairy on both surfaces as well as on margins; petiole short, about 0.5 cm, hairy. Peduncles hairy, longer than petioles, about 1 cm long. Flowers in axillary peduncled cymes, 1–2 cm long, dark purple; pedicels glabrous. Calyx minute, 0.2–0.3 cm long; corolla tube 1–1.2 cm long; narrow from base to the mouth; upper lobes short, linear-lanceolate, one third the length of the tube, gently curved and forms a short crown. Outer corona entire, hairy; inner erect, linear. Follicles cylindrical, terete, 4–6 cm long.

Habitat.—A single population of the species on temperate grassland slopes and scrub near Nyakha-Lachen village (North Sikkim) was located at an altitude of 2700 m. It grew with other herbaceous species like *Anaphalis contorta* (D. Don) Hook.f., *Anemone obtusiloba* D. Don, *Drosera peltata* Thunb., *Eulalia mollis* (Griseb.) O. Kuntze., *Euphorbia wallichii* Hook.f., *Polygonatum cirrhifolium* (Wall.) Royle, *Pteris nepalensis* H. Ito, *Roscoea purpurea* Sm. and *Vincetoxicum hirundinaria* Medik. Among shrubs, the associates of the species were *Eurya acuminata* DC., *Gaultheria nummularioides* D. Don, *Pieris formosa* (Wall.) D. Don, *Rhododendron arboreum* Sm., etc. This locality has shallow to moderately deep coarse loamy soil with sandy loam surface texture. The area receives high rainfall during June to August with an average rainfall of ca. 2500 mm. The average minimum/ maximum temperature range between 4.2°C–17.1°C and 13.9°C–23.9°C in this region. In winter this region receives high snowfall and remains under snow intermittently from late December to February.

Distribution.—India: North Sikkim; Bhutan; Nepal; Tibet.

Status.—During the explorations only a single population of 8–10 individuals (Fig. 1) could be located. The majority of the individuals in this locality were adults and in flowering/fruiting stages. Juvenile stages of the species were not encountered. Attempts to relocate the species from localities like Zemu area, from where it was recorded earlier, were unsuccessful.

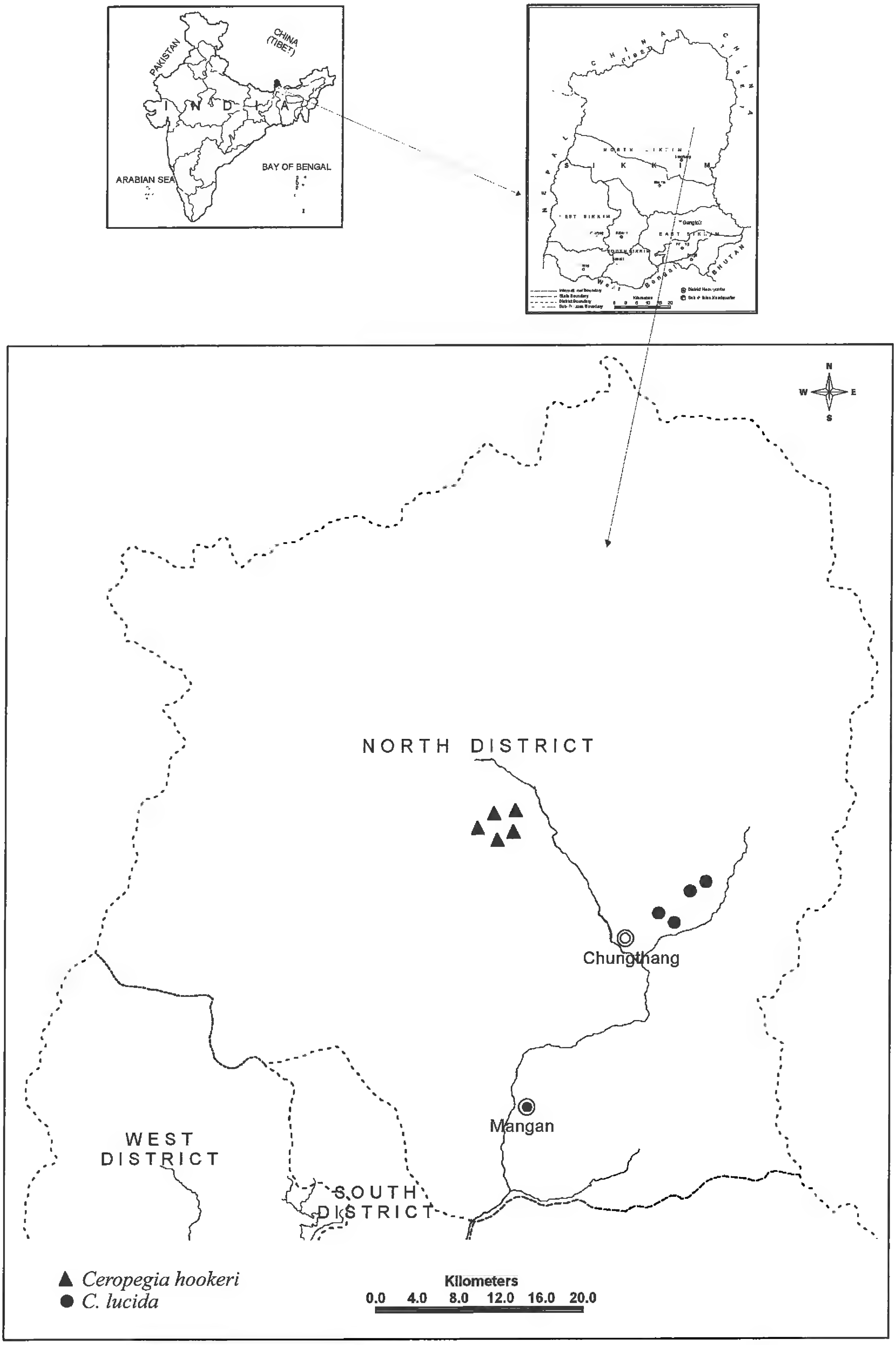

PAKISTAN
CHINA (TIBET)
INDIA
ARABIAN SEA
BAY OF BENGAL
CHINA (TIBET)
NEPAL
NORTH SIKKIM
SIKKIM
WEST SIKKIM
EAST SIKKIM
SOUTH SIKKIM
Gangtok
BHUTAN
West Bengal
N
W
E
S
NORTH DISTRICT
Chungthang
Mangan
WEST DISTRICT
SOUTH DISTRICT
▲ Ceropegia hookeri
● C. lucida
Kilometers
0.0 4.0 8.0 12.0 16.0 20.0

Fig. 1. Map of the study area showing collection sites of *Ceropegia* spp.

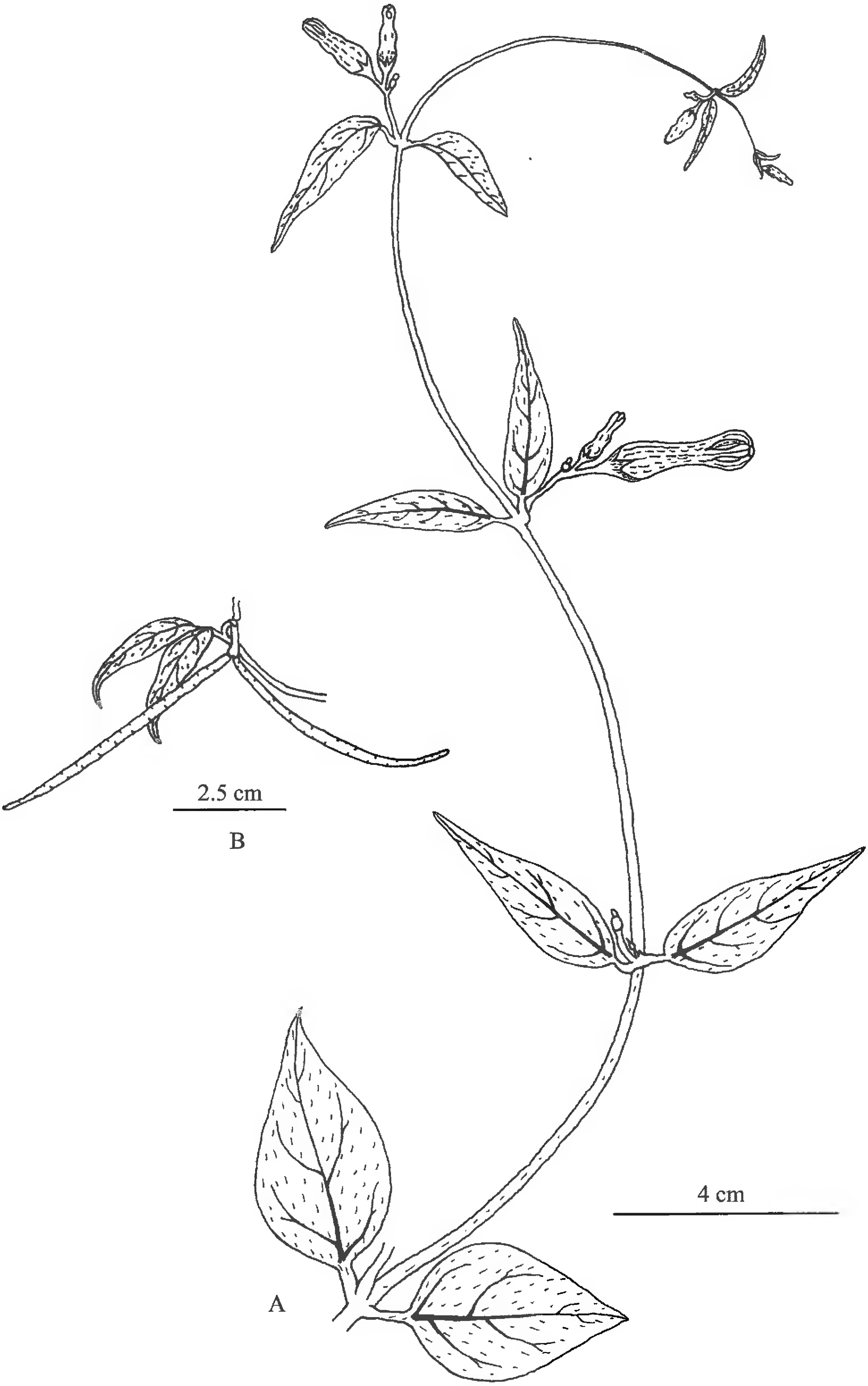


Fig. 2. Line diagram of *Ceropegia hookeri* C.B. Clarke ex Hook.f. Flowering twig (A) and Fruit (B).

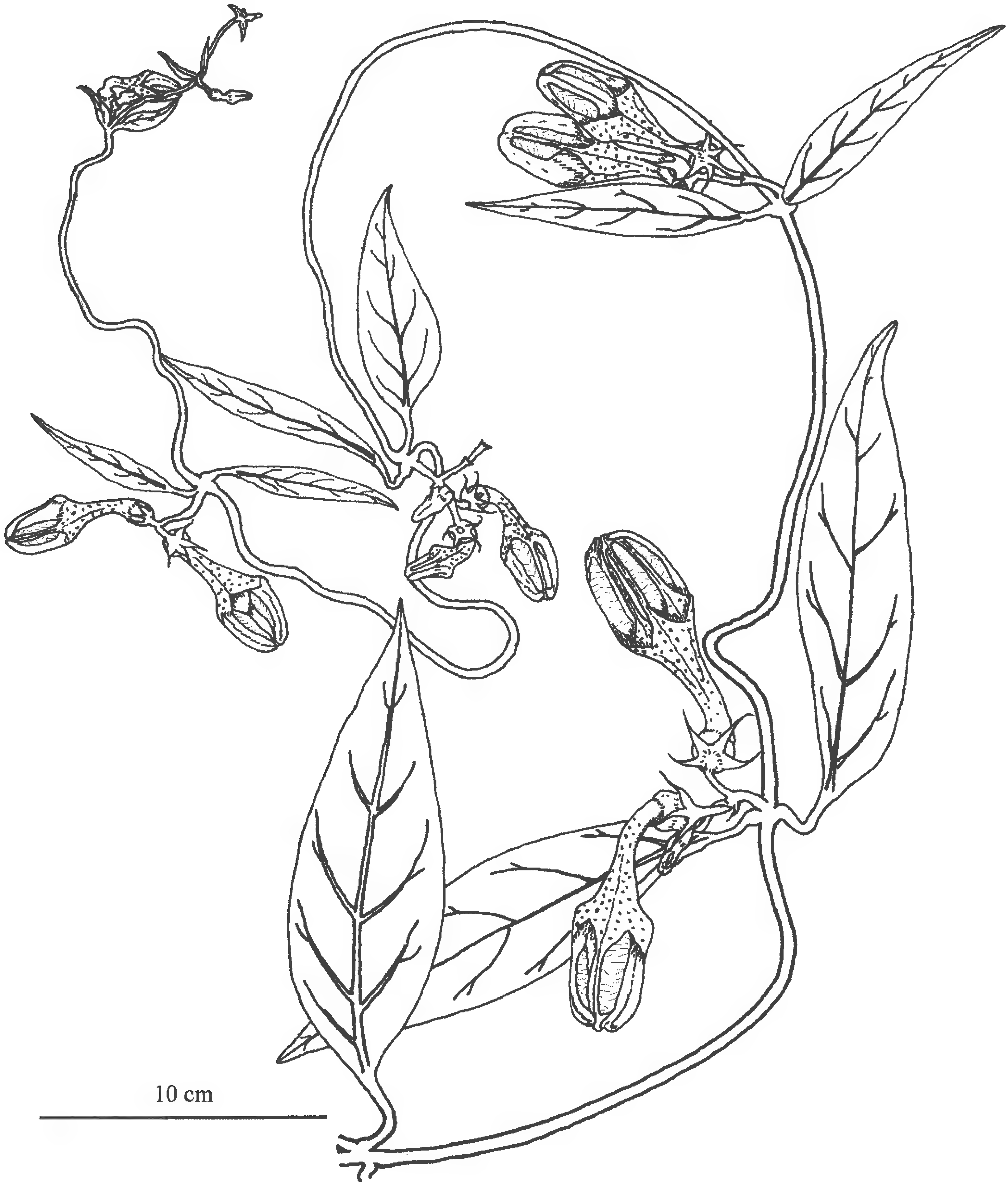


Fig. 3. Line diagram of *Ceropegia lucida* Wall.

Conservation threat.—The species is threatened by habitat loss due to a number of human activities. These include agricultural expansion, road building and grazing by domestic animals. A number of tourists also visit these areas and owing to its showy flowers, these plants become targets of removal, which is also poses a serious threat to the survival of this species.

Ceropegia lucida Wall. Pl. As. Rar. 2:33, t. 139. 1831; Hook.f. Fl. Brit. India 4:73.1885; Kanjilal & Bor. Fl. Assam 3:309. 1939; Ansari, Fasc. Fl. India 16:22. 1984.

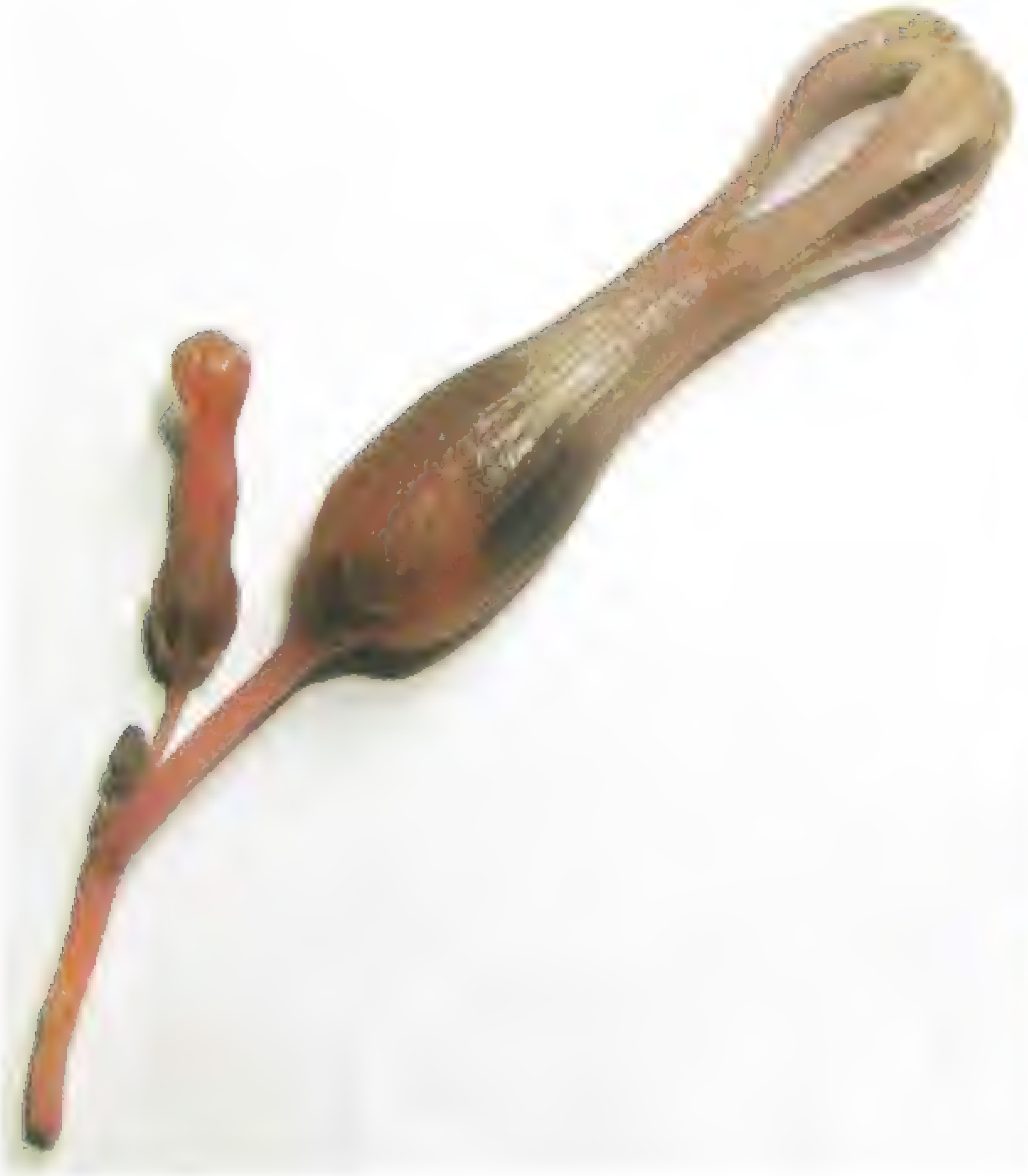


Fig. 4. A flower of *Ceropegia hookeri*.

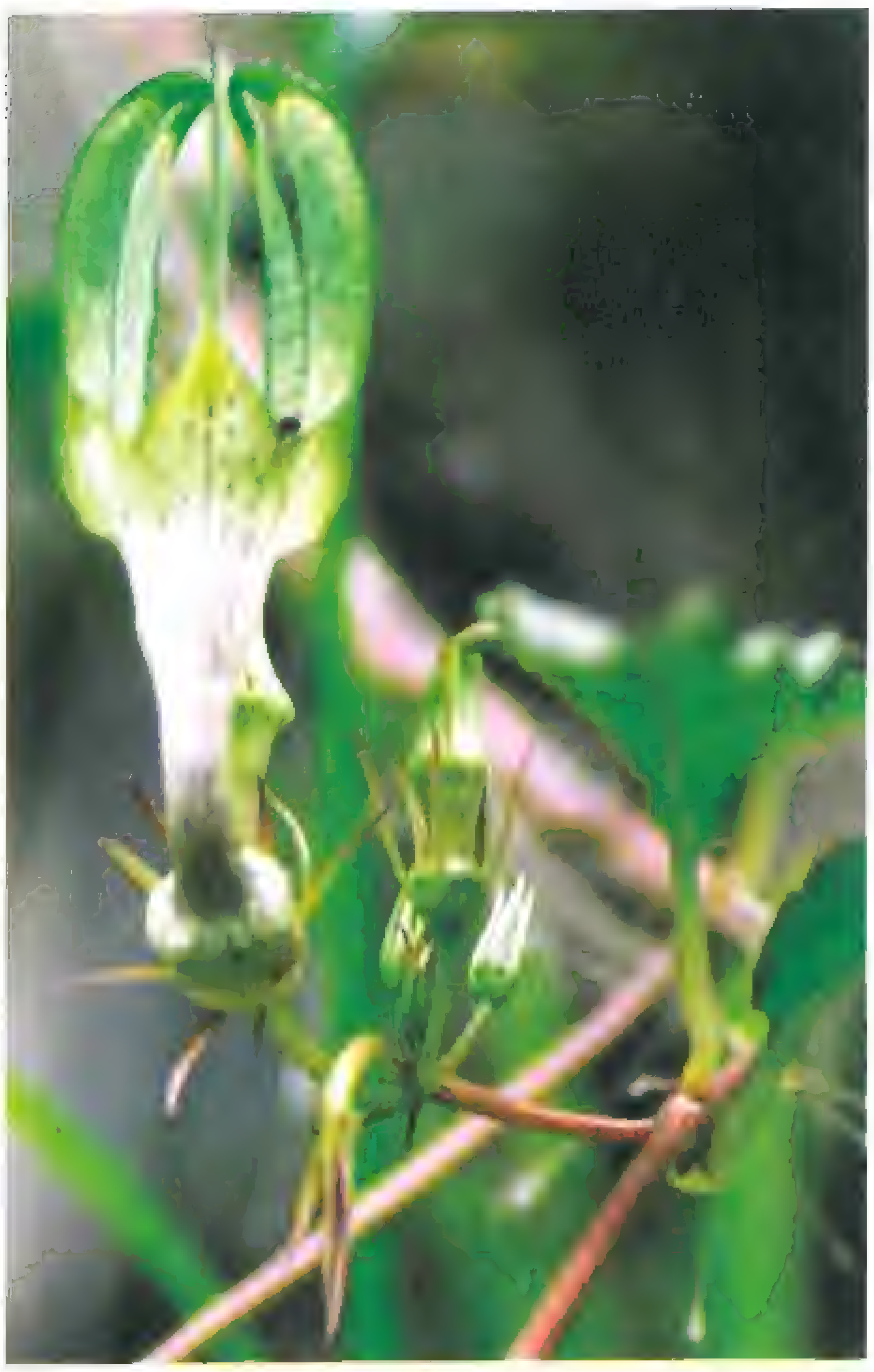


Fig. 5. A plant of *C. lucida* in its natural habitat. Note its showy flowers; the shape of the flower resembles a fountain from where the genus derives its name.

Long twining, sparsely hairy or glabrous herbs, with tuberous roots. Stem solid, long creeping, up to 2 m long. Leaves membranous, ovate or lanceolate, petiolate, 6.5–10.5 cm long and 1.5–2.5 cm wide; petiole short, 0.5–1.1cm long. Peduncles short, 1.5–2 cm long, hairy in line. Flowers few (5), in axillary peduncled cymes; pedicels glabrous. Calyx small, about 0.7 cm long; corolla curved, 3.5–4.5 cm long, sparsely dialated at the base, green spotted with purple; upper corolla lobes linear, about 2 cm long, ciliate within the spathulate apex. Outer corona of 5 bifid-deltoid ciliate lobes; inner erect, linear-clavate.

Habitat.—Two populations of *C. lucida* were located near Lachung village (North Sikkim) at an altitude of 1750 m in a damp grassland/scrub (Fig. 4). The scrub was comprised of scattered trees such as *Alnus nepalensis* D. Don, *Carpinus viminea* Wall. ex Lindl, *Erythrina arborescens* Roxb., *Lyonia ovalifolia* (Wall.) Drude, *Rhus hookeri* Sahni & Bahadur and *Salix disperma* Roxb. ex D. Don. *Ceropegia lucida* often twines on other herbaceous species like *Artemisia parviflora* D. Don, *Chrysopogon gryllus* (L.) Trin., *Capillipedium assimile* (Steud.) A. Camus, *Colocasia affinis* Schott., *Commelina benghalensis* L., *Cynoglossum glochidiatum* Wall. ex Benth., *Didymocarpus pedicellatus* R. Br., *Heracleum nepalense* D. Don, *Persicaria capitata* (D. Don) H. Gross and *Stephania elegans* Hook.f.& Thomson. This locality has shallow, loamy skeletal soil with gravelly sandy loam surface texture. The area is humid almost round the year and receives high rainfall during June to August with an annual average rainfall of ca 3000 mm with the average minimum/maximum temperatures ranging between 5–16°C and 14.7–24.8°C.

Distribution.—India: Sikkim, Meghalaya; Bangladesh, Burma, China, Hong Kong, Malaysia, Thailand.

Status.—During the exploratory surveys two populations comprising 8–10 individuals could be located (Fig. 1). All the individuals in this locality were adults and in flowering and fruiting stages. We undertook field exploration to various localities in Sikkim from where the occurrence of this species was reported earlier. We could not relocate this species at the known localities like Lower and Upper Rayang.

Conservation threat.—The populations suffer from habitat loss due to agriculture expansion, overgrazing and road construction activities, particularly in Rayang valley from where it was recorded earlier. These habitats have undergone major land use changes due to on-going human activities.

DISCUSSION

Ceropegia hookeri C.B. Clarke ex Hook.f. is one of the poorly known endangered species of Himalaya. It was first reported from its type locality, Lachen valley in North Sikkim (Clarke 1879). In the nineteenth-century, the species was collected from Zemu valley and the adjacent Tibet Himalaya and its specimens deposited in the Central National Herbarium, Kolkata (see Nayar & Sastry 1988). Apart from the type, only a few specimens from Zemu valley are available at CAL (July, 1909; 2 sheets). Since then, this species has remained elusive, though the area of its occurrence has been extensively surveyed by different research groups from India and abroad. Grierson and Long (1999) reported the species from Lachen and Chumbi valleys. A few sheets—reportedly of this species—from Lingthem in upper Zongu, Rang Rang, Bichu and Chungthang areas, are in the Botanical Survey of India herbarium, Sikkim Himalaya Circle (SHC), Gangtok. These sheets neither matched Hooker's description of the species (Hooker 1885) nor with the few specimens at CAL. It seems that the sheets at SHC may have been wrongly ascribed to *C. hookeri*. In view of the wrong identity of the specimens at SHC, Gangtok, our paper places on record the occurrence of *C. hookeri* from its type locality, Lachen, North Sikkim. We collected this species from Lachen valley at an altitude of 2700 m during 2003 and continued to observe the population through 2004–2006. The specimen of *C. hookeri* from Lachen agrees with the Hooker's description (Hooker 1885) and confirms its type locality. It is apparently endemic to Lachen and possibly to the adjoining Nepal Himalaya, where it has been reported earlier (Hooker 1885).

Ceropegia lucida Wall. was first reported from Sylhet in Bangladesh (Wallich 1831). In India, its collection history dates back to nineteenth-century when Hooker collected it from Khasia Hills (Meghalaya), followed by the collection of Keenam from Cachar (Assam) and King (1874) from the banks of the Rayang River, in Sikkim. Since there was no fresh collection of this species after 1874, it was considered as endangered or possibly extinct (Nayar & Sastry 1988). Collection of this species from Lachung Valley is therefore of significant interest to conservationists and taxonomists and marks its rediscovery after a gap of over hundred years. Also, this species is reported for the first time from North Sikkim, thus extending its range of distribution from previously reported tropical zone to the temperate Himalayan region. It may be too early to suggest, but likely, that the species may have shifted its geographic range upwards under the influence of global warming (see Davis & Shaw 2001). The occurrence of the species in Lachung valley (1750 m) and its disappearance from its known localities like Lower and Upper Rayang, do suggest the possibility of a range shift. However, the other likely cause of species extinction of *Ceropegia lucida* from its known localities appears to be habitat destruction due to agricultural expansion, overgrazing, and road construction activities in Rayang Valley. These habitats have undergone major land use changes due to ongoing human activities (Pandit et al. 2007). Additionally, the tubers of some *Ceropegia* species are known to be consumed locally by humans during periods of scarcity (see Nayar & Sastry 1987, 1988). Enquiries among the local population, however, revealed that the tubers of *Ceropegia* are not consumed at present. However, the respondents did not rule out the possibility of consumption of tubers in the past, in these inaccessible terrains, during the times of food shortage. This biotic pressure on the species in the past might have accentuated the problem of dwindling numbers of this species in nature. All these pressures seem to be responsible for pushing the species to the brink of extinction.

Both *C. hookeri* and *C. lucida* have low population sizes and are threatened by habitat loss due to a number of human activities. It is well known that many Himalayan plant species with low population sizes face survival risks (Pandit 1998, 2003). Humid conditions and adequate amount of water in the soil seem to be essential for their growth in the natural habitat. Due to these specific habitat requirements, the species are difficult to cultivate at other places. To save these species from extinction efforts are on to multiply them through seeds and tubers and reintroduce them in their natural habitats. Besides, there is an urgent need for carrying out detailed biological and ecological studies on these species and their habitats need to be brought under some kind of protective regulation.

Ex-situ conservation strategies

Propagating by seeds in habitats with similar ecological conditions or in nearby botanic gardens will be useful in ex-situ conservation of these species. Micropropagation using tissue and organ culture needs to be explored for mass multiplication and reintroduction into the wild. Since the population sizes of these species are small, harvesting of plants or plant parts from the wild should be strictly prohibited. In addition, there is a need to understand the reproductive biology, genetic architecture, and evolutionary relationship of these species to ensure their reestablishment in nature and multiplication in botanic gardens, herbal gardens, and other protected areas.

ACKNOWLEDGMENTS

The authors are thankful to H.M. Mukherjee, Central National Herbarium, Kolkata (CAL) for permission and help with the herbarium. The financial support for the research project sanctioned to M.K. Pandit vide project no. J.12011/11/99-IA.I. from the Ministry of Environment, Forests and Wildlife, Government of India and National Hydro-electric Power Corporation, Faridabad, is gratefully acknowledged. Two reviewers, E.S. Santhosk Kumar and one anonymous, provided helpful reviews.

REFERENCES

Ansari, M.Y. 1984 Fascicles of flora of India, fascicle 16, Asclepiadaceae, genus *Ceropegia*. Botanical Survey of India, Kolkatta. Pp 1–34.

CISMHE. 2007. Carrying capacity studies of Teesta basin in Sikkim, Vol. IV, Ministry of Environment & Forests, Govt. of India, New Delhi.

Davis, M.B. and R.G. Shaw. 2001. Range shifts and adaptive responses to Quaternary climate change. Science 292:673–679.

Grierson, A.J.C. and D.G. Long. 1999. Flora of Bhutan. Vol. 2, Part 2. Royal Botanic Garden, Edinburgh. Pp 728–730.

Hara, H., A.C. Chater, and L.H.J. Williams. 1982. An enumeration of flowering plants of Nepal. Vol. III, London.

Hooker, J.D. 1885. Flora British India. Vol. IV. London. Repr. Bishen Singh Mahendra Pal Singh, Dehra Dun.

Jagtap, A.P. and N. P. Singh. 1999. Fascicles of flora India 24, Botanical Survey of India, Kolkata. Pp 211–241.

Kanjilal, U.N. and N.L. Bor. 1939. Flora of Assam. Vol. III. New Delhi.

Kavade, S.P. and P.G. Diwakar. 2004. *Ceropegia pubescens* Wall. (Asclepiadaceae) – A new distributional record for Peninsular India. J. Econ. Taxon. Bot. 28:113–116.

King, G. 1874. Cited from CAL herbarium, Botanical Survey of India, Kolkata.

Nayar, M.P. and A.R.K. Sastry. 1987. Red data book of Indian Plants. Vol. I. Botanical Survey of India, Kolkata.

Nayar, M.P. and A.R.K. Sastry. 1988. Red data book of Indian Plants. Vol. II. Botanical Survey of India, Kolkata.

Nayar, M.P. and A.R.K Sastry. 1990. Red data book of Indian Plants. Vol. III. Botanical Survey of India, Kolkata.

Pandit, M.K. and C.R. Babu. 1998. Biology and conservation of *Coptis teeta* – an endemic and endangered medicinal herb of Eastern Himalaya. Environm. Conservation 25:262–272.

Pandit, M.K. and C.R. Babu. 2003. The effects of loss of sex in clonal populations of an endangered perennial *Coptis teeta* (Ranunculaceae). Bot. J. Linn. Soc. 143:47–54.

Pandit, M.K., N. Sodhi, L.P. Koh, A. Bhaskar, and B.W. Brook. 2007. Unreported yet massive deforestation driving loss of endemic biodiversity in Indian Himalaya. Biodivers. & Conservation 16:153–163.

Wallich, N. 1831. Plantae Asiaticae rariores 2:33. t. 139.

NOTES ON THE TAXONOMIC HISTORY OF TWO RARE SPECIES OF *BEGONIA* (BEGONIACEAE) FROM SIKKIM HIMALAYA AND THEIR CONSERVATION

D.C. Nautiyal, S.K. Sharma, and M.K. Pandit[1]

Centre for Interdisciplinary Studies of Mountain & Hill Environment
Academic Research Centre Building
University of Delhi, Delhi -110007, INDIA

ABSTRACT

Begonia satrapis C.B. Clarke and *B. scutata* Wall. are two rare species known from Eastern Himalaya. *Begonia satrapis* is an endemic of Sikkim and Darjeeling Himalaya, while *B. scutata* is reported to occur in Sikkim and the adjacent Nepal Himalaya. In this contribution we review their collection history, reassess their present conservation status, and identify various threats to their survival in nature. We found that many of the species' populations have disappeared and the existing ones have considerably shrunk to small sizes. *Begonia satrapis* was represented by only three scattered populations in the adjoining localities comprising about 40–50 individuals each. Likewise, *B. scutata* was represented by three populations of about 10–15 individuals each. We suggest urgent *ex situ* and *in situ* conservation measures for saving these species from extinction.

Key Words: *Begonia satrapis*, *B. scutata*, endemic, rare, habitat loss, Sikkim Himalaya

RESUMEN

Begonia satrapis C.B. Clarke y *B. scutata* Wall. Son dos especies raras conocidas del este del Himalaya. *Begonia satrapis* es endemica de Sikkim y Darjeeling, mientras que *B. scutata* se ha citado de Sikkim y el Nepal adyacente. En esta aportación revisamos la historia de sus recolecciones, confirmamos su estatus de conservación actual, e identificamos varias amenazas para su supervivencia en la naturaleza. Hemos encontrado que muchas poblaciones de la especie han desaparecido y las existentes se han reducido considerablemente a tamaños pequeños. *Begonia satrapis* está representada únicamente por tres poblaciones esparcidas en localidades vecinas que contienen unos 40–50 individuos cada una. De modo semejante, *B. scutata* está representada por tres poblaciones de unos 10–15 individuos cada una. Sugerimos medidas de conservación urgentes *ex situ* e *in situ* para salvar estas especies de la extinción.

INTRODUCTION

Sikkim, with a geographical area of 7096 sq km, is a small state of India located in the Eastern Himalaya. Owing to its varied altitudinal gradient (240–8,598 m), diverse habitats and high rainfall, the area supports a rich flora in its tropical, sub-tropical, temperate and alpine ecosystems. This region has been identified as one of the global hot spots of biological diversity (Myers et al. 2000). This rich diversity has of late come under severe pressure and as a result a large number of plant taxa are threatened in this region (Nayar & Sastry 1987, 1988, 1990). Recent studies suggest probability of large scale extinctions of Himalayan plant species following habitat loss (Pandit et al. 2007).

The first assessment of conservation status of Indian plant species about two decades ago (Nayar & Sastry 1987, 1988, 1990), could not be followed by intensive studies on taxa faced with survival risks. With increasing pressures of overexploitation and habitat loss, several species have been restricted to only a few populations and individuals in Eastern Himalaya (Pandit & Babu 1998, 2003). Sikkim Himalaya, particularly, is one of the richest areas of floristic diversity where a number of plant taxa are reported to be facing risk of survival. It is estimated that at least 45 species of flowering plants are known to be facing varying degrees of threat in Sikkim Himalaya (Nayar & Sastry 1987, 1988, 1990; Singh & Chauhan 1998). The habitats are under threat from increasing human population, expanding agriculture and a plethora of developmental activities. In Sikkim, proposed large-scale hydro-power projects along Teesta River and on its tributaries, pose a serious threat to habitats, which are likely to cause unprecedented species population losses if proper care is not taken to rescue them (CISMHE 2007). In view of the impending hydro-power developmental activities

---

[1] Corresponding author, e-mail: mkpandit@cismhe.org

J. Bot. Res. Inst. Texas 3(2): 823 – 830. 2009

in Sikkim Himalaya, a survey and assessment of the rare and threatened plant biodiversity in the area was taken up so as to understand the magnitude of their population loss and also to suggest corrective measures.

MATERIALS AND METHODS

During a series of recent plant explorations (2002–2006) in Sikkim Himalaya, we collected specimens of *Begonia* L. from the tropical and sub-tropical regions in South Sikkim (Fig. 1). After critical study, review of literature and consultation of specimens at Central National Herbarium (CAL), Kolkata and Botanical Survey of India, Sikkim Circle, Gangtok, (SHC), our *Begonia* collections were identified as *B. satrapis* C.B. Clarke and *B. scutata* Wall. The locations of the various populations of the two species in Sikkim were mapped using Leica – GS5 GPS (global positioning system). The voucher specimens were deposited in the CISMHE Herbarium, University of Delhi, Delhi, India with duplicates being deposited at the Herbarium of Botanical Survey of India Sikkim Himalaya Circle, Gangtok (SHC) after publication of this study. During the surveys, the habitat conditions, plant associates as well as biotic and abiotic pressures, were recorded in order to asses the threat the *Begonia* populations.

RESULTS

Notes on the taxonomic description, habitat, distribution, population status in the study area, and conservation methods are described below. Illustrations of *Begonia satrapis* and *B. scutata* are provided in Figures 2 and 3, respectively.

Begonia satrapis C.B. Clarke, in Hooker, Fl. Brit. India 2:638. 1879.

Tall pubescent herbs, with a tuberous rootstock. Stem erect or shortly decumbent, 24–28 cm long, usually elongate above the radical leaves. Leaves reniform or ovate-acuminate, 4–9 x 4.5–12cm, cordate at the base, minutely denticulate, ciliate, closely pubescent above, rufous-villous on the nerves beneath; stipules lanceolate, pubescent. Peduncle elongate, up to 7 cm, densely pubescent; bracts persistent oblong-lanceolate, hairy. *Male flower:* pedicel 1.5–2 cm, pubescent; tepals 2+2, the outer larger, about 1cm long, pubescent; the inner smaller, 0.5 cm long, glabrous; stamens many, monoadelphous; anthers obovoid, 0.1cm long, connective absent. *Female flower:* pedicel long, about 3 cm, pubescent; tepals 2+3, the outer larger, about 0.6 cm long, pubescent, inner smaller, glabrous; styles 3, separate. *Fruit:* capsule with 3 equal wings, about 1.5 cm long, pubescent. Seeds ellipsoid.

Habitat.—The populations were located around Sumbuk and Kitam, in Rangit Valley (South Sikkim) at altitudes of 550–1100 m. *Begonia satrapis* grows in tropical and sub-tropical mixed deciduous forests consisting of trees like *Callicarpa arborea* Roxb., *Gmelina arborea* Roxb., *Ostodes paniculata* Blume, *Phoenix sylvestris* (L.) Roxb., *Schima wallichii* Choisy, *Shorea robusta* C.F. Gaertn., *Tectona grandis* L.f. and *Terminalia myriocarpa* Van Heurck & Müll-Arg. The species is usually associated with other herbaceous species such as *Ageratina adenophora* (Spreng.) R.M. King & H. Rob., *Capillipedium assimile* (Steud.) A. Camus *and Cymbopogon flexuosus* (Nees ex Steud.) Will.Watson. *Begonia satrapis* prefers shaded rocky forest floors near the forest fringes and the areas along road cuttings. The species is found restricted to a narrow area in the Majitar Forest Block in South Sikkim. The habitat is exploited for harvesting of timber trees, fodder, fuel wood, and other human activities.

Distribution.—Sikkim (Rangit Valley), West Bengal (Darjeeling district).

Population mapping and status.—Only three isolated populations of *B. satrapis* around Sumbuk (lat. 27°6'19"N, long. 88°22'07"E at alt. 550 m; lat. 27°06'06"N, long. 88°23'07"E at alt. 555 m) and Kitam (27° 07'42"N and 88°21'04'E at 1100 m) in South Sikkim (Fig. 1) were encountered during the study. Each of these populations comprised 40–50 individuals and the majority of them were in flowering and fruiting stages. However, no seedlings of the species could be located.

Threat.—We observed that the natural habitat of *B. satrapis* is under severe biotic pressure. The number and geographic area of the type localities of the species have been considerably reduced owing to activities like agricultural expansion, road-widening, and fodder collection by the local population.

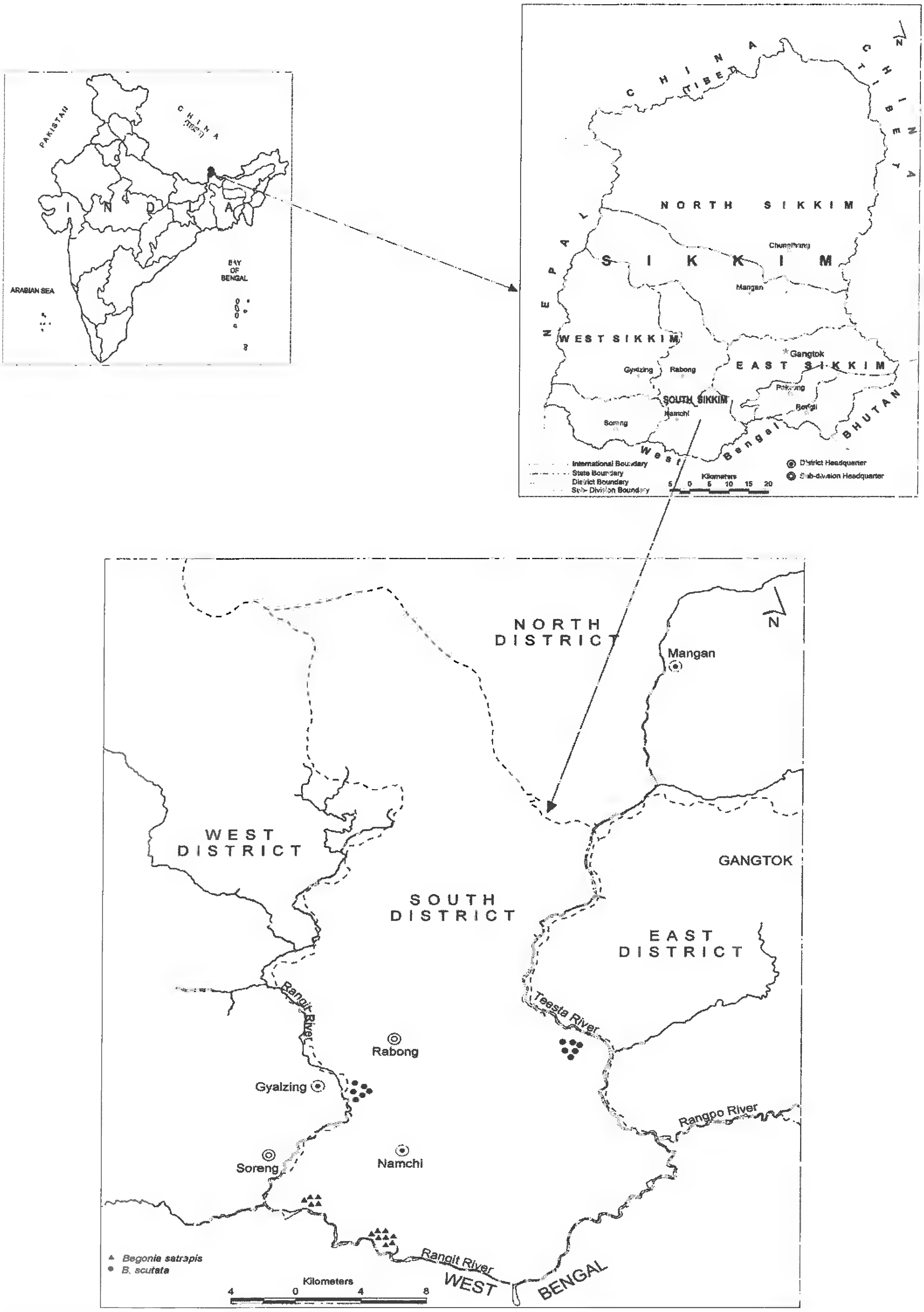

PAKISTAN
CHINA (TIBET)
INDIA
ARABIAN SEA
BAY OF BENGAL
CHINA (TIBET)
NEPAL
BHUTAN
NORTH SIKKIM
SIKKIM
WEST SIKKIM
EAST SIKKIM
SOUTH SIKKIM
Chungthang
Mangan
Gangtok
Gyalzing
Rabong
Pakyong
Rongli
Namchi
Soreng
West Bengal
International Boundary
State Boundary
District Boundary
Sub-Division Boundary
Kilometers
5 0 5 10 15 20
District Headquarter
Sub-division Headquarter
N
NORTH DISTRICT
Mangan
WEST DISTRICT
SOUTH DISTRICT
GANGTOK
EAST DISTRICT
Rangit River
Teesta River
Rabong
Gyalzing
Rangpo River
Soreng
Namchi
Rangit River
WEST BENGAL
▲ Begonia satrapis
● B. scutata
Kilometers
4 0 4 8

Fig. 1. Map of the study area (Sikkim) and location of the populations of *Begonia satrapis* and *B. scutata*. Note that the populations of these two species are restricted to South Sikkim.

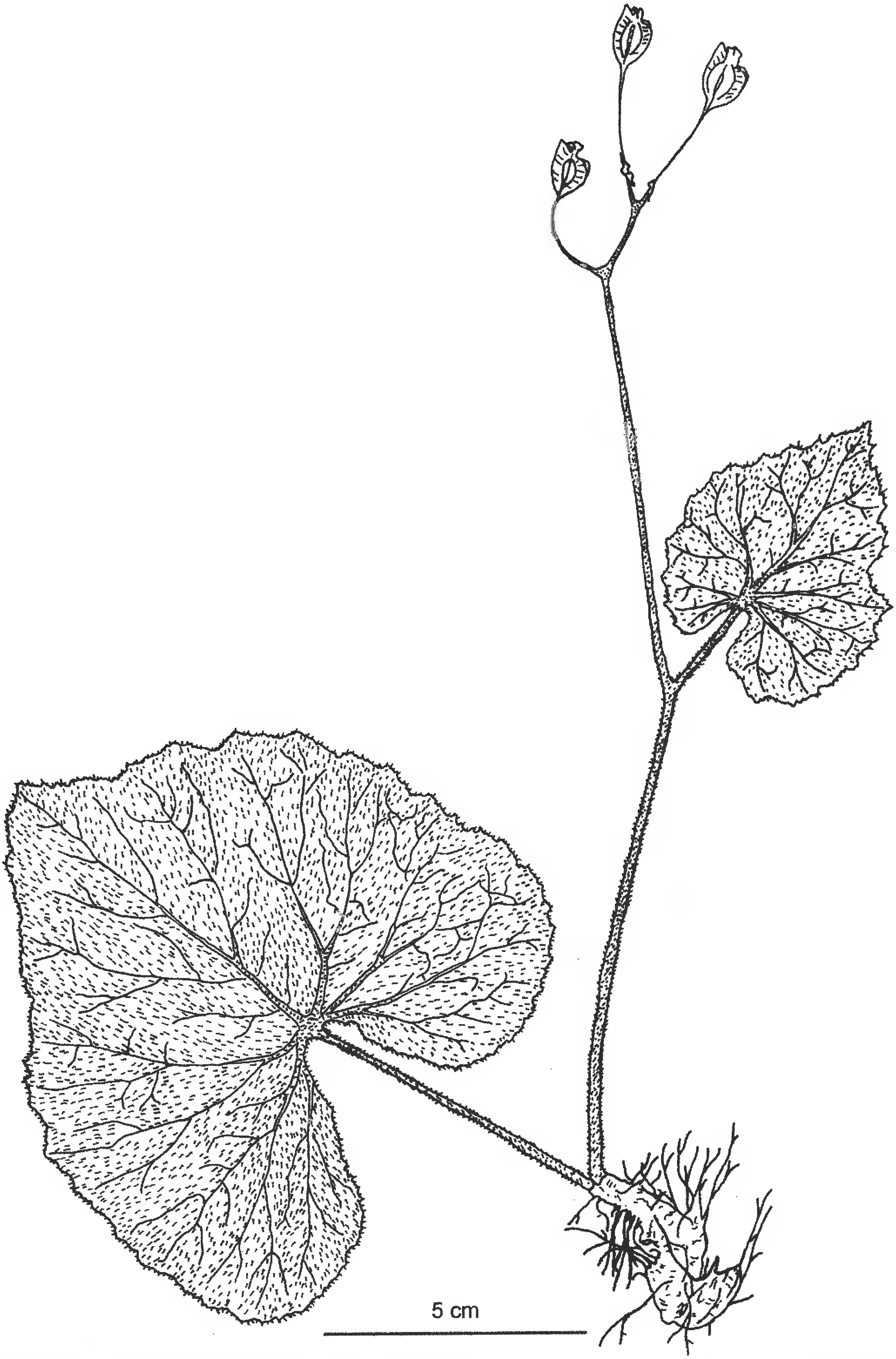


Fig. 2. Line drawing of *Begonia satrapis* C.B. Clarke.

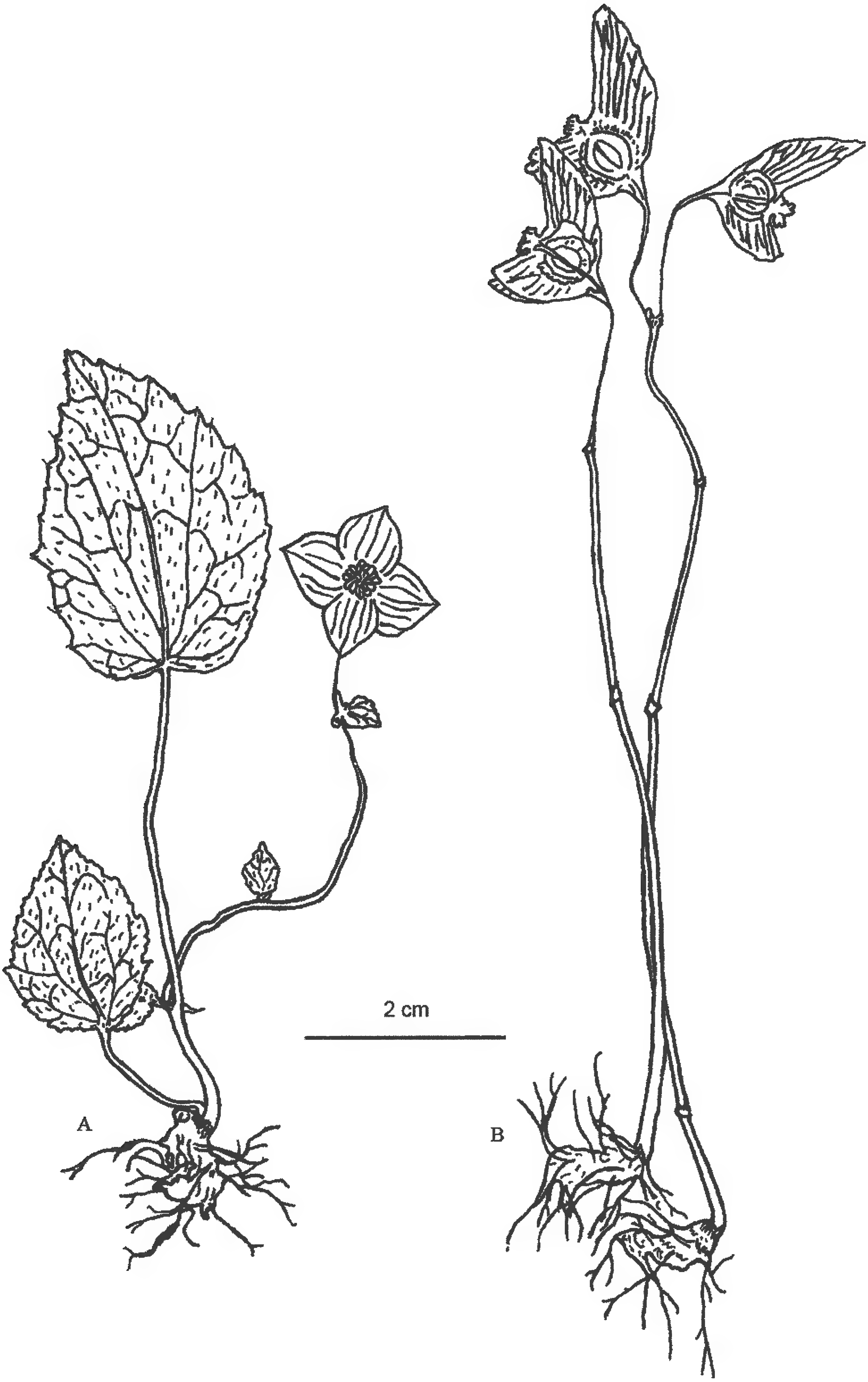


Fig. 3. Line drawing of *Begonia scutata* Wall. Plant with male flower (A) and female plant with capsules (B).

Collection history.—Begonia satrapis has not been collected from the Rangit hills since 1910. There are only two herbarium sheets deposited in the Central National Herbarium (CAL) which were collected by Ribu and Rhomo (Griffith Herbarium), from Rangit, dated October 7, 1910 and these are without flowers. Biswas (1966) reported the occurrence of *B. satrapis* from the adjoining (Darjeeling district), West Bengal, however, no voucher specimens were found at CAL and SHC herbaria for reference.

Begonia scutata Wall., Prodr. 15(1):328.1864; Clarke, in Fl. Brit. India 2:642. 1879.

Small, glabrous herbs with a very short tuberous rootstock. Stem erect, filiform, 7–14 cm high, leafless in fruiting stage. Leaves ovate-acute, cordate at base, irregularly serrate margins, minutely pubescent on the nerves beneath; petiole filiform, 2–4 cm long in cauline leaf, longer up to 7 cm in radical leaves. Peduncles 5–7cm long, 2–3 flowered; bracts caducous. *Male flower:* pedicel about 1cm long; tepals 2+2, the outer tepals ovate, 1 × 0.8 cm, pubescent, the inner smaller, 0.5 × 0.4 cm, glabrous; stamens about 20, shortly monoadelphous; anthers obovoid. *Female flower:* tepals 2+1, the outer tepals rounded, 0.8 cm in diameter, the inner one smaller, 0.4 cm wide; styles 3, distinct, shortly bifid above. *Fruit:* capsules, unequally 3-winged, the larger wing 0.9 cm wide, smaller wing about 0.2 cm wide. Seeds ellipsoid.

Habitat.—Three populations of *B. scutata* were located near Yangyang in Teesta Valley and Legship in Rangit Valley (South Sikkim) at altitudes of 300–1200 m. These populations inhabited open, tropical, and sub-tropical mixed deciduous secondary forests. The surrounding vegetation in the habitat comprised of trees like *Bombax ceiba* L., *Canarium strictum* Roxb., *Engelhardtia spicata* Blume, *Erythrina arborescens* Roxb., *Garuga pinnata* Roxb., *Gynocardia odorata* R. Br., *Schima wallichii* Choisy and *Toona ciliata* M. Roem. The main herbaceous associates of *B. scutata* include *Begonia picta* Sm., *Cissus repens* Lam., *Didymocarpus pedicellatus* R. Br., *Pilea scripta* (D. Don) Wedd., *Persicaria capitata* (D. Don) H. Gross, *Urtica dioica* L. and *Selaginella aitchisonii* Hieron. *Begonia scutata* grows on sandy, wet soils, and rocky strata.

Distribution.—Himalaya: Sikkim, West Bengal (Darjeeling); Nepal; Peninsular India.

Population mapping and status.—Only three populations of *B. scutata* around Legship (lat. 27°16'25"N, long. 88°16'49"E at 300 m alt.; lat. 27°16'28.27"N, long. 88°16'48"E at 400 m alt.) and Yangyang (lat. 27°16' 49"N, long. 88°24'45"E at 1100 m alt.) could be observed in South Sikkim (Fig. 1). Each of these populations comprised 10–15 individuals and the majority of these were in flowering/fruiting stages.

Threat.—The vast forested tracts in the distribution range of the species have already been cleared for agriculture and road construction purposes. The habitats are being continuously disturbed and degraded owing to various activities being undertaken in those areas such as road construction, sand mining, and agricultural expansion.

Collection history.—This species was first collected by Wallich in 1821 and its type specimen is available in CAL. It was later reported from Eastern Himalaya (Sikkim and Darjeeling) by Biswas (1966) and Grierson and Long (1991). Apart from the type (Wallich 1821) only a few other specimens without flowers are available in CAL.

DISCUSSION

Begonia satrapis and *B. scutata* are listed as rare species in the Red Data Book of Indian Plants (Nayar & Sastry 1990). *Begonia satrapis* is a very rare plant and was reported to occur only in Rangit valley in Sikkim Himalaya (Hooker 1879). The CAL specimens of *B. satrapis*—collected by Ribu and Rhomo, G.H. Cave and I.H. Burkil during 1875 to 1914 from the hills of Rangit—are fairly old and do not represent adequate material for its proper identity. Though, Biswas (1966) reported the occurrence of the species from Darjeeling, no specimen of his collections was found at either CAL or SHC. Reports of Grierson and Long (1991) suggest presence of the species in Darjeeling and Sikkim Himalaya. Apart from the type and a few specimens of *B. satrapis* by Ribu and Rhomo (1910), available at CAL, no other specimen of this species has been preserved anywhere in the Indian herbaria. Therefore, the recent collection of these species by the authors after a long gap is noteworthy.

Begonia scutata was first collected by Wallich in 1821 and described by De Candole in 1864 from Nepal. This species was later reported from Sikkim and Darjeeling Himalaya (Biswas 1966) and Nepal Himalaya (Hara 1966). A collection of the species from a new locality in Peninsular India by Kumar and Banerjee (1989) could not be verified as the specimen of their collection was not found at CAL. Grierson and Long (1991) have recorded this species near Reshap in Darjeeling Himalaya and described it as *B. rubella*. However, our taxonomic evaluation of the specimens and descriptions reveal that *B. rubella* and *B. scutata* are two distinct species (see also Nayar & Sastry 1990). Apart from the type specimen of Wallich (CAL), no other authentic specimen of *B. scutata* was located in other Indian herbaria.

The populations of *B. satrapis* and *B. scutata* in South Sikkim were mapped and various threats faced by these species were assessed. It was observed that the population sizes of the two species are small and their habitats face severe pressure from various anthropogenic activities including road-widening, tree felling, expansion of agricultural fields, grazing, etc. In a recent work, Pandit et al. (2007) have reported that large scale species extinction is likely to occur in Himalaya following deforestation and continuing land use changes. Studies have shown that reduction in the population size occurs due to the human activities in their habitats which lead to the reduction of genetic diversity and rarity of the species (Godt et al. 1998; Di Battista 2007). The present study indicates that *Begonia satrapis* is represented by merely three scattered populations of about 40–50 individuals dispersed over an area of 2–3 sq km each. Additionally, regular collection of fodder and fuel wood from the forest floors by humans seems to be a serious threat to the survival of this species in its natural habitat.

Begonia scutata is represented by only three populations comprising about 10–15 individuals each. These populations survive in the degraded forests along river banks, which are threatened by activities like road construction, sand mining, and agricultural expansion. These habitats are the last bastions of its survival and the species may be consigned to extinction once these habitats are lost. The two species of *Begonia* discussed here are faced with probable extinction. To save these species from being lost efforts are under way to locate more populations of these taxa, multiply them, and re-introduce them in their natural habitats. As such, there is an urgent need for carrying out detailed biological and ecological studies on these species for their proper conservation. To begin with the habitats of these species need to be brought under protective regulation before these species are lost forever. We also recommend that if activities such as road extension, agricultural expansion are unavoidable in these habitats, the last remaining populations of these species must be rescued and rehabilitated to safer habitats within the region.

Ex-situ conservation strategies

Re-establishing wild populations of *B. satrapis* and *B. scutata* in suitable habitats that do not have severe habitat pressure can prove to be an effective means of ex-situ conservation. Since both the species of *Begonia* have limited number of individuals and small population sizes, adequate measures such as cultivating these species in nearby botanic gardens and parks should be undertaken. For a long-term conservation program, establishing seed banks will be essential.

ACKNOWLEDGMENTS

The authors are thankful to H.M. Mukherjee, Central National Herbarium, Kolkata (CAL) for permission and help with the herbarium. The financial support for the research project sanctioned to M.K. Pandit vide project no. J.12011/11/99-IA.I. from the Ministry of Environment, Forests and Wildlife, Government of India and National Hydro-electric Power Corporation, Faridabad, is gratefully acknowledged. Two anonymous reviewers kindly reviewed and thus improved the manuscript.

REFERENCES

Biswas, K.P. 1966. Plants of Darjeeling and Sikkim Himalaya, Vol. I. Kolkata. P. 377.

Cismhe. 2007. Carrying capacity studies of Teesta basin in Sikkim, Vol. IV, Ministry of Environment & Forests, Govt. of India, New Delhi.

De Candolle, A. 1864. Reg. Veg. Prod. 153:328.

Di Battista, J.D. 2007. Patterns of genetic variation in anthropogenically impacted populations. Cons. Genet. (online first, April 12, 2007).

Grierson, A.J.C. and D.G. Long. 1991. Flora of Bhutan, Vol. 2, Part 1. Royal Botanic Garden, Edinburgh. Pp. 241–242.

Godt, M.J.W., B.R. Johnson, and J.L. Flourich. 1998. Genetic diversity and population size in four rare Southern Appalachian plant species. Conservation Biol. 10:796–805.

Hara, H. 1966. The flora of Eastern Himalaya: results of botanical expedition of eastern Himalaya. Tokyo. Pp. 1–215.

Hooker, J.D. 1879. Flora British India. Vol. II. L Reeve & Co. London. Pp. 638–642.

Kumar, K.D. and R.N. Banerjee 1989. A note on *Begonia scutata* Wall. ex DC. (Begoniaceae). J. Econ. Tax. Bot. 13:247–248.

Myers, N., R.A. Mittermeier, C.G. Mittermeier, G.A.B. da Fonseca, and J. Kent. 2000. Biodiversity hotspots for conservation priorities. Nature 403:853–858.

Nayar, M.P. and A.R.K. Sastry. 1987. Red Data Book of Indian Plants. Vol. I. Botanical Survey of India, Kolkata.

Nayar, M.P. and A.R.K. Sastry. 1988. Red Data Book of Indian Plants. Vol. II. Botanical Survey of India. Kolkata.

Nayar, M.P. and A.R.K. Sastry. 1990. Red Data Book of Indian Plants. Vol. III. Botanical Survey of India, Kolkata.

Pandit, M.K. and C.R. Babu. 1998. Biology and Conservation of *Coptis teeta*—an endemic and endangered medicinal herb of Eastern Himalaya. Environm. Conservation 25:262–272.

Pandit, M.K. and C.R. Babu. 2003. The effects of loss of sex in clonal populations of an endangered perennial *Coptis teeta* (Ranunculaceae). Bot. J. Linn. Soc. 143:47–54.

Pandit, M.K., N.S. Sodhi, L.P. Koh, A. Bhaskar, and B.W. Brook. 2007. Unreported yet massive deforestation driving loss of endemic biodiversity in Indian Himalaya. Biodivers. Conservation 16:153–163.

Singh, P. and A.S. Chauhan. 1998. An overview of plant diversity of Sikkim. In: S.C. Rai, R.C. Sundriyal, and E. Sharma, eds. Sikkim Perspectives for Planning & Development. Sikkim Science Society, Sikkim. Pp. 219–233.

STATUS ASSESSMENT OF *ELEOCHARIS WOLFII* (CYPERACEAE) IN THE UNITED STATES

Paul M. McKenzie
U.S. Fish and Wildlife Service[1]
101 Park DeVille Dr.; Suite A
Columbia, Missouri 65203, U.S.A.
paul_mckenzie@fws.gov

C. Theo Witsell
Arkansas Natural Heritage Commission
1500 Tower Building, 323 Center St.
Little Rock, Arkansas 72201, U.S.A.
theo@arkansasheritage.org

Loy R. Phillippe
Illinois Natural History Survey
607 East Peabody Dr.
Champaign, Illinois 18820, U.S.A.
rickp@inhs.uiuc.edu

Christopher S. Reid
Louisiana Natural Heritage Program
Louisiana Department of Wildlife & Fisheries
2000 Quail Dr.
Baton Rouge, Louisiana 70898, U.S.A.
creid@wlf.louisiana.gov

Michael A. Homoya
Division of Nature Preserves
Indiana Department of Natural Resources
402 West Washington St.; Room 267
Indianapolis, Indiana 46204, U.S.A.
mhomoya@dnr.IN.gov

Steven B. Rolfsmeier
Kansas State University Herbarium
Manhattan, Kansas 66506, U.S.A.
srolfsm2@yahoo.com

Caleb A. Morse
R.L. McGregor Herbarium
University of Kansas Campus West
2045 Constant Ave.
Lawrence, Kansas 66047, U.S.A.
cmorse@ku.edu

ABSTRACT

Eleocharis wolfii (Wolf's spike-rush) is listed by NatureServe as G3G4 and as S1 (critically imperiled), S2 (imperiled), SNR/SU (not ranked or currently under review), or SH (historical) in most states where the species has been documented. Recent field studies in Arkansas, Illinois, Kansas, Louisiana, Missouri, and Nebraska suggest that the species is not as rare as previously believed but simply overlooked. Pre-1978, the species was known from 59 sites in 43 counties/parishes in 17 states and possibly two others. Post-1978, Wolf's spike-rush has been documented at 222 sites from 104 counties/parishes scattered across 16 states. Since 2000, 135 new sites distributed among 64 counties/parishes in 15 states have been discovered. *Eleocharis wolfii* is easily recognized in the field by the combination of tiny rhizomes; purple-red culm bases; blue-green, flattened and spirally twisted culms; and mostly white achenes < 1.0 mm long with 9–19 longitudinal ridges and 30–60 transverse trabeculae. The species is known from a wide variety of habitats including wet depressions of bottomland and mesic upland prairies, ephemeral pools in open grasslands, limestone and saline barrens, and ephemeral pools or shallow depressions on sandstone, granite, or quartzite outcrops. *Eleocharis wolfii* may be found in nearly pure monoculture stands but is often found with a wide variety of plant associates depending on soil and natural community type. Significant threats to *Eleocharis wolfii* habitat persist over much of its range and include the cutting of many bottomland forests; habitat destruction due to residential and commercial development; the conversion of native prairie to agricultural crops, pasture or hayfields; and the loss of wetlands. There are insufficient regulatory mechanisms in place in most states to provide any protection for the species. The potential impact of projected climate change on *E. wolfii* is unknown. Planned increases in ethanol production in the Midwest may negatively affect the species. Additional surveys are needed in the Midwest, the Great Plains states, and states bordering or adjacent to the Great Lakes. The species would benefit from additional research including studies on life history and ecology; seed viability; population genetics; germination requirements; inter-specific competition; land use changes; and the potential impacts of invasive species. Management actions that may benefit Wolf's spike-rush include prescribed fire, haying or mowing to retard the encroachment of woody vegetation on prairie habitats, and low levels of soil disturbance to enhance germination and soil growth.

RESUMEN

Eleocharis wolfii está listada por el NatureServe como G3G4 y como S1 (críticamente amenazada), S2 (amenazada), SNR/SU (no catalogada pero actualmente en revisión), o SH (posiblemente eliminada) en la mayoría de los estados donde la especie ha sido documentada. Recientes estudios de campo en Arkansas, Illinois, Kansas, Louisiana, Missouri, y Nebraska sugieren que la especie no es tan rara como se creía previamente sino que simplemente había pasado inadvertida. Antes de 1978, la especie se conocía de 59 lugares en 43 condados/

---

[1] The findings and conclusions in this article are those of the author(s) and do not necessarily represent the views of the U.S. Fish and Wildlife Service.

J. Bot. Res. Inst. Texas 3(2): 831 – 854. 2009

parroquias de 17 estados y posiblemente otros dos. Después del1978, se ha documentado en 222 sitios de 104 condados/parroquias distribuidos por 16 estados. Desde 2000, se han descubierto 135 nuevas localidades distribuidas por 64 condados/parroquias en 15 estados. *Eleocharis wolfii* se reconoce fácilmente en el campo por la combinación de rizomas finos; bases de los culmos rojo-púrpura; culmos verde-azulados, aplastados y retorcidos espiralmente; y aquenios blancos < 1.0 mm de longitud con 9–19 costillas longitudinales y 30–60 trabéculas transversales. La especie se conoce de una amplia variedad de hábitats que incluyen praderas en depresiones húmedas de fondo de valle y mésicas de tierras altas, charcas temporales el praderas abiertas, baldíos calizos y salinos, y charcas temporales o depresiones someras en afloramientos de areniscas, granitos, o cuarcitas. *Eleocharis wolfii* puede encontrarse casi en cultivos puros pero a menudo se encuentra con una variedad de plantas asociadas dependiendo del tipo se suelo y tipo de comunidad natural. Existen amenazas importantes sobre el hábitat de *Eleocharis wolfii* en gran parte de su distribución que incluyen la tala de bosques; destrucción del hábitat por el desarrollo comercial y residencial; la conversión de praderas naturales en tierras de cultivo, pastos o prados; y la pérdida de humedales. Hay insuficientes mecanismos reguladores en la mayoría de los estados para proteger la especie. El impacto potencial del cambio climático proyectado sobre *E. wolfii* no se conoce. Los planes de incrementar la producción de etanol en el medio oeste pueden afectar negativamente a la especie. Se necesitan estudios adicionales en el Medio Oeste, estados de las grandes llanuras, y estados alrededor de los Grandes Lagos. La especie podría beneficiarse de investigaciones adicionales que incluyan estudios de su ciclo vital y ecología; viabilidad de las semillas; genética de poblaciones; requerimientos para la germinación; competencia interespecífica; cambios en el uso del territorio; y los impactos potenciales de especies invasoras. Las acciones de gestión que pueden beneficiar a *E. wolfii* incluyen la prohibición del fuego, siega o desbroce para retardar la invasión de la vegetación leñosa en los hábitats de pradera, y bajos niveles de alteración del suelo para favorecer la germinación y el desarrollo del suelo.

INTRODUCTION

Eleocharis R. Br. is a cosmopolitan genus of Cyperaceae that consists of approximately 200 species worldwide. Smith (2002) recognized 67 species of *Eleocharis* in North American north of Mexico. No recent comprehensive worldwide taxonomic treatment is available. González-Elizondo and Peterson (1997) recognized four subgenera in a worldwide supraspecific classification of *Eleocharis*: subgenus *Eleocharis*, subgenus *Limnochloa* (P. Beauv. ex T. Lestib.) Torr., subgenus *Scirpidium* (Nees) Kukkonen and subgenus *Zinserlingia* T.V. Egorova. Most North American treatments of *Eleocharis* rely heavily on the extensive studies by Svenson (1929, 1932, 1934, 1937, 1939, 1957) and they include difficult species complexes that need taxonomic revision (Smith 2002).

Eleocharis wolfii (A. Gray) A. Gray ex Britton in Patt. (Wolf's spike-rush) is native but scattered and local from North Dakota south to Texas and east to Georgia, Virginia (Godfrey & Wooten 1979; Kolstad 1986; Robertson & Phillippe 1992; Yatskievych 1999; Smith 2002) and New York where it is considered by some to be adventive (e.g., Svenson 1957). Galen Smith could not locate specimens to substantiate previous reports of the species from Alberta, Saskatchewan, and Colorado (Smith 2002). *Eleocharis wolfii* is a member of subgenus *Scirpidium*. Members of this subgenus are characterized by having 3-fid styles and diagnostic trigonous to nearly terete achenes with distinct tubercles and conspicuous cancellate cells or fine horizontal ridges (trabeculae) between prominent longitudinal ridges or achene angles (Smith 2002). Smith (2002) recognized seven species within subgenus *Scirpidium* north of Mexico including *E. wolfii*. Wolf's spike-rush is named for John Wolf who collected the type specimen in Fulton County, Illinois (Gray 1874; Mohlenbrock 1976; Phillippe 2005).

Botanical nomenclature listed herein follows Yastkievych (1999) or Yatskievych and Turner (1990), except for *Carex aureolensis, C. opaca, Crataegus brachyacantha, Dichanthelium dichotomum* ssp. *dichotomum, D. scoparium, Isolepis pseudosetacea, Juncus coriaceus, Ludwigia linearis, L. palustris, Quercus similis, Ranunculus laxicaulis, Rhynchospora globularis* var. *globularis, R. recognita* and *Steinchisma hians* which follow Arkansas Vascular Flora Committee (2006); *Eleocharis coloradoensis, E. elliptica, E. montevidensis* and *E. tenuis* which follow Smith (2002); *Hierochloë odorata, Polygonum careyi,* and *Rhamnus frangula* which follow Swink and Wilhelm (1994); *Bidens trichosperma, Boltonia diffusa, Euthamia gymnospermoides, E. leptocephala, Doellingeria umbellata, Helenium flexuosum, Iva annua,* and *Symphyotrichum lanceolatum* which follow Yatskievych (2006); and *Eriophorum polystachion* and *Triglochin maritima* which follow Kolstad (1986). Botanical nomenclature for the mosses *Climacium* and *Sphagnum* follows United States Department of Agriculture, National Resources Conservation Service (2009). Author citations and abbreviations follow Brummitt and Powell (1992).

Plant description (from Smith 2002)

Plants perennial, rhizomatous, may grow in small circular clumps (tussocks) or often coalescing to form large mats (Fig. 1a–d); light brown to white rhizomes 0.25–0.6 mm thick (Fig. 2a), internodes 1–4 cm, the stems in erect or decumbent tufts or clumps along the rhizome (Fig. 2a), scales 2 mm. **Culms** erect (sometimes decumbent when dry), sides variably smooth or with 1 to few acute ridges (often nearly smooth or with 1 ridge on 1 side and several ridges on the other), greatly compressed (Fig. 1e–f & Fig. 2b), usually inrolled when dry, rectangular in cross section, 8 to 50 cm × 0.3–1.5 mm, 0.2–0.5 mm thick, firm, margins often sharply acute, margins and often 1 or more ridges minutely serrulate at 20–30 ×. **Leaves**: leaf sheaths persistent, dark red, brown, or straw-colored proximally (Fig 2a), terminating at the acute apex as a thin, hyaline tooth that may be split and free from the culm (slightly inflated). **Spikelets** ovoid or lanceoloid, 3–9 × 1.5–2.5 mm, apex acute (Fig. 2b); 15–30 imbricate, ovate floral scales with acute apexes (Fig. 2b,d), scales dark red, orange-brown, stramineous, or colorless, and generally with broad hyaline margins and tip, the prominent midrib stramineous, brown, or greenish, ovate-lanceolate, (2.2–)2.7–3.2 × 1.5 mm (Fig. 2d). The 2 lower basal scales usually larger. **Flowers**: perianth bristles absent; anthers 3, 1.1–1.75 mm, style trifid, wind pollinated. **Achenes** brown, gray, or nearly white, lustrous, compressed-trigonous, obovoid, mostly 2 times longer than wide, 0.7–0.9(–1.1) × (–0.4)0.5 mm, with angles and 9–19 longitudinal ridges and 30–60 transverse trabeculae (Fig. 2c). **Tubercles** brownish, pyramidal, 0.1–0.15 × 0.2–0.25 mm (Fig 3a, 3b). **Fruiting** late spring-early summer (May–June). Although not mentioned in most references outside of McKenzie and Jacobs (2000), Robertson and Phillippe (1992), and Phillippe (2005), the culms of *E. wolfii* are usually bluish-green and conspicuously twisted in a diagnostic spiral (Fig. 1e–f). Based on personal experience of the authors, the bluish-green and spirally twisted culms of Wolf's spike-rush provides for immediate recognition in the field, especially when associated with other species of *Eleocharis* spp.

Eleocharis wolfii most closely resembles and is sometimes confused with *Eleocharis acicularis* (L.) Roem. & Schult., especially var. *porcata* S.G. Sm. Smith (2001a) described variety *porcata* based on material that was collected mostly from the Great Plains. Due to the need to revise the taxonomy of subgenus *Scirpidium* on a global scale, and the variability associated with *E. acicularis* sensu lato, Smith (2002) did not formally recognize var. *porcata* in his *Flora of North America* treatment. Smith (2001a) provided the specific epithet *porcata* due to the presence of 6–12 prominent ridges on the culms, but also noted that this variety has flattened stems, and is therefore similar to, and possibly confused with, *E. wolfii*. *Eleocharis wolfii* can be distinguished from *E. acicularis var. porcata* by the combination of twisted, blue-green culms (Fig. 1e–f) with fewer (1–3) sharp ridges and usually longer spikelet scales [(2.2–)2.7–3.2 mm] (Smith 2002). *Eleocharis acicularis* var. *porcata* has dark green culms with 6–12 blunt ridges and shorter spikelet scales [(1.5–)2–2.5 mm] (Smith 2001a, 2002). *Eleocharis wolfii* also usually has wider culms (0.3–1.5 mm) than *E. acicularis* var. *porcata* (0.2–0.5 mm). The generally narrower culms of *E. acicularis* give this species a wiry appearance (pers. obs.). Additionally, *E. acicularis* usually has shorter culms that form dense, low growing, often sterile mats that superficially resemble sterile clumps of *E. parvula* (Roem. & Schult.) Link ex Bluffet al. (Mohlenbrock 1976), *E. coloradoensis* (Britton) Gilly, or the small fern *Pilularia americana* A. Braun, species with which it sometimes associates (pers. obs.). Smith (2001a, 2002) reported that *E. acicularis* var. *porcata* has been misidentified as *E. wolfii* at some localities. Although confusion between the two taxa could occur where the two taxa are sympatric (Smith 2001a), the characters identified above should readily separate *E. wolfii* from *E. acicularis* var. *porcata*, especially for culms of *E. wolfii* that are > 0.8 mm wide. Finally, *E. wolfii* is typically not found in the same habitat as *E. acicularis*. *Eleocharis acicularis* is often found on the shores of ponds, lakes, vernal pools, sloughs, ditches and frequently on disturbed habitats (Godfrey & Wooten 1979; Yatskievych 1999; Smith 2002). As noted by Robertson and Phillippe (1992), Swink and Wilhelm (1994), Smith (2002), Phillippe (2005), and others, *E. wolfii* is usually associated with native, mostly undisturbed habitats. *Eleocharis wolfii* was cited as a weed in Asia and Pacific Islands by Holm et al. (1979) and Moody (1989), respectively. There are, however, no vouchers to verify the identity of these claims (Charles Bryson, USDA, pers. comm. 2009).

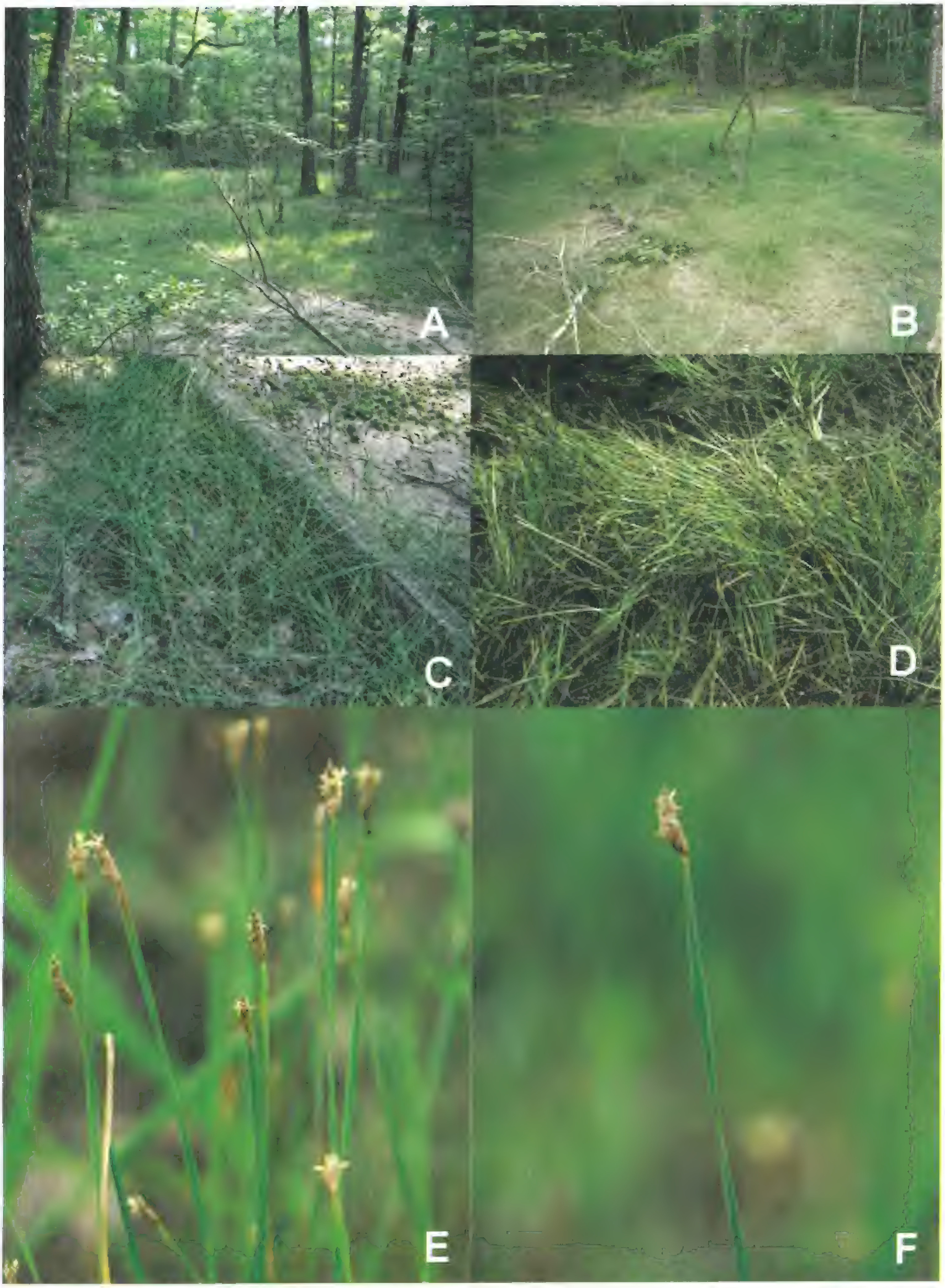


Fig. 1. **a–d: Clumped habit of *Eleocharis wolfii* (a, b, & c photos by Theo Witsell, Saline County, AR; d photo by John Pelton, Prairie County, AR); e–f: flattened and sprially twisted culms of *Eleocharis wolfii* (photos by Christopher Reid, Morehouse Parish, LA).**

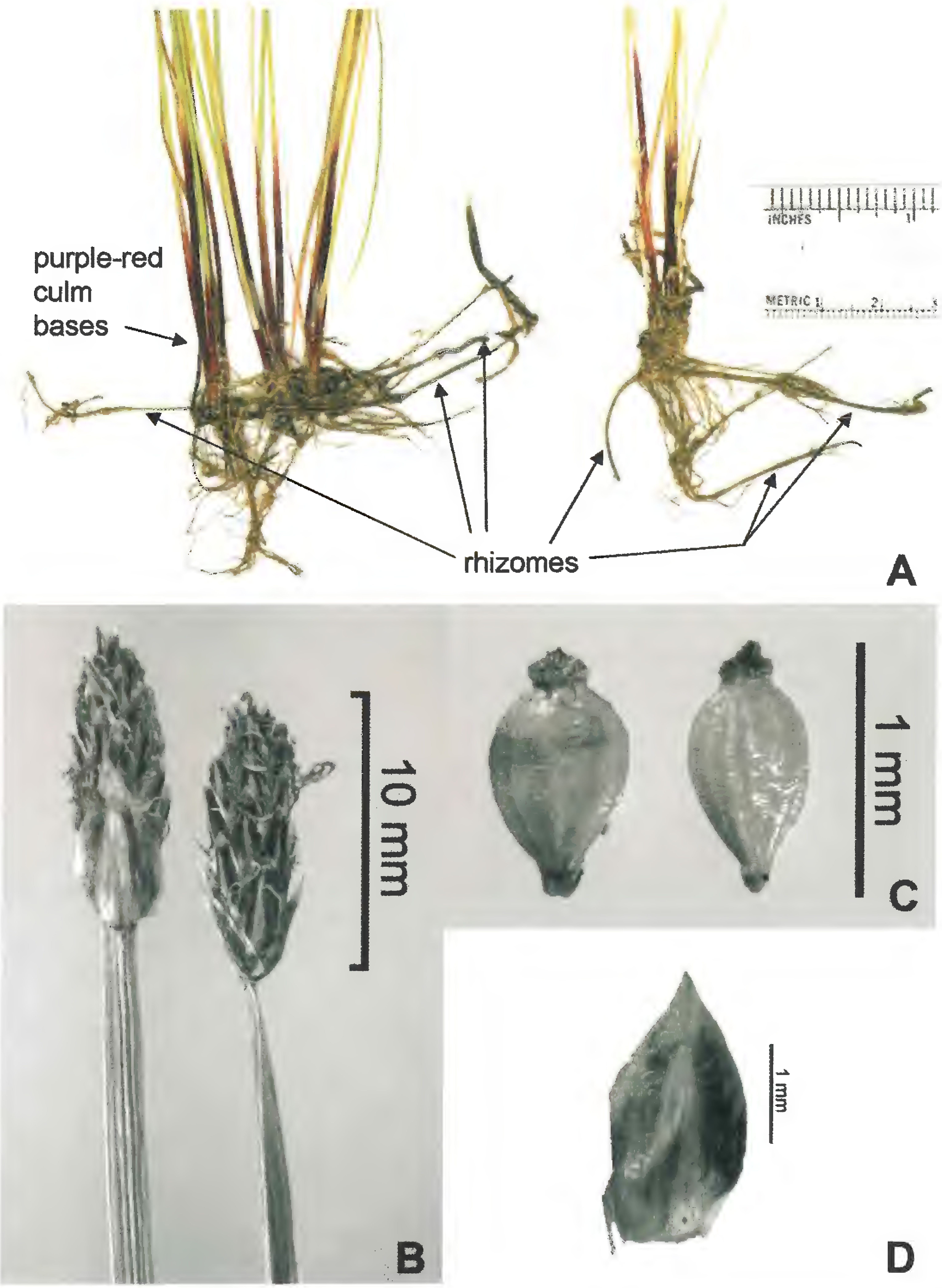

purple-red culm bases
rhizomes
INCHES
METRIC
A
10 mm
B
1 mm
C
1 mm
D

Fig. 2. **a:** Purple-red culm bases and very thin white to tan rhizomes of *Eleocharis wolfii* (photo by Theo Witsell, from Witsell #07-24 [ANHC]; Hempstead County, AR); **b–d:** closeup of spikelets, achenes, and floral scale of *Eleocharis wolfii* (photos by George Yatskievych)

Based on field observations of the authors, *E. wolfii* produces flower and fruit for about a 3–4 week period. After fruiting, spikes often become disarticulated from the stem and the stems turn brown or wither (McKenzie & Jacobs 2000). Populations of Wolf's spike-rush occurring in flatwoods under shaded conditions may contain mostly sterile culms that lie prostrate or decumbent on the forest floor (Fig. 1a–c) (Robertson & Phillippe 1992, McKenzie & Jacobs 2000, Phillippe 2005). Specimens of *E. wolfii* in such areas of reduced light intensity tend to be etiolated, and produce fewer fruiting individuals and fewer achenes per spikelet (Robertson & Phillippe 1992) and achenes are often immature or abortive (McKenzie & Jacobs 2000). Fertile and sterile culms of *E. wolfii* can be identified by the combination of very narrow rhizomes, purple-red culm bases, and conspicuously flattened and spirally twisted culms (Fig. 1e–f; 2a).

The habit of *E. wolfii* is variable depending on soil type and natural community type (see below). At many sites, the species is often hidden among taller vegetation where it can be difficult to detect, especially late in the season when spikelets are absent and the culms no longer exhibit their conspicuous blue-green color (Fig. 1e–f). At some sites, however, the species can form large colonies that are in nearly pure stands (Fig. 1a–d).

Previous evaluations by the United States Fish and Wildlife Service (USFWS)

Eleocharis wolfiii was listed as a Category 2 (C2) candidate species in the USFWS's 1993 Plant Candidate Review for Listing as Endangered or Threatened Species (U.S. Fish & Wildlife Service 1993). Category 2 candidate species comprised taxa for which information indicated that a proposal to list as endangered or threatened was possibly appropriate, but for which conclusive data on biological vulnerability and threats were not currently available to support proposed rules.

On 19 Jul 1994, the Director of the USFWS issued a memorandum establishing new policy on the definition of candidate species (formerly Category 1 or C1) and how the USFWS would consider species for which they remained concerned (formerly C2). Under the new policy, candidates are defined as those species for which the USFWS has on file sufficient information on biological vulnerability and threats to support issuance of a proposed rule to list as endangered or threatened, but issuance of the proposed rule is precluded by other listing actions.

Former C2 species for which the USFWS lacks sufficient information to classify as candidate species will no longer be enumerated on an official list. Nonetheless, other agencies that have developed extensive databases on former C2 species [e.g., The Nature Conservancy (TNC) & state Natural Heritage programs] will continue to monitor these species and maintain communication with the USFWS to further assess the status of these species in their respective states. This information will be useful in determining when there is sufficient information to warrant their addition to the USFWS's list of candidate species.

Eleocharis wolfii is a species the USFWS continues to monitor and the lack of a comprehensive summary of the species' rangewide status and distribution, coupled with the large number of populations discovered in the central U.S. since 2000, is partly the impetus for initiating the current assessment.

In 2003, the authors began a status review of *E. wolfii* and solicited information from species experts and botanists throughout the range of the species. Information received from such requests is provided in this report. Although we could not find any published results of a rangewide survey of this species conducted in North America, S. Galen Smith compiled a distribution map of *E. wolfii* in his 2002 *Flora of North America* treatment (Smith 2002). Martin (1993) drafted a status report of *E. wolfii* for the USFWS but the document was never finalized (Karen Kreil, USFWS, pers. comm. 2006). Phillippe (2005) prepared a conservation assessment for the U.S. Forest Service on *E. wolfii* and provided information on the species' taxonomy, life history, habitat requirements, ecology, range-wide distribution and abundance, conservation status, population biology and viability and known or suspected threats. NatureServe (2009) provided the projected current distribution of *E. wolfii* for North America, listed global and state ranks outlining the species global rarity and conservation status in each state in the United States and included information on ecology and life history, habitat requirements, and threats to the species.

Recent field surveys conducted primarily in Arkansas, Kansas, Louisiana, Missouri, and Nebraska between 2000 and 2008 and in Indiana between 1983 and 1995 have yielded numerous new localities for the species (Phillippe 2005). The new discoveries suggest that the species may be more common than previously believed and simply overlooked. To obtain a more complete depiction of the current range of the species, including recently collected data, we referenced recently published and unpublished survey results, published accounts (Godfrey & Wooten 1979; Kolstad 1986; Robertson & Phillippe 1992; McKenzie & Jacobs 2000; Smith 2002; Phillippe 2005; Diggs et al. 2006), as well as accounts provided by personnel of various state Natural Heritage programs and Academia.

Distribution

A summary of historical and extant documented occurrences of *E. wolfii* in the United States is provided in Table 1 and Figure 3. We define any records documented prior to 1978 to be historical and those recorded after that date to be extant. Historically (includes some counties that have extant populations), Wolf's spike-rush was known from approximately 59 sites scattered across 43 counties of 20 states (Table 1). Of these, 31 sites are known solely from historical collections (Table 2; Fig. 3). Within the last 30 years, *E. wolfii* has been collected at 222 sites in 104 counties of 16 states (Table 1) and over 61% of these sites (135) and 62% of the counties (64) have been documented since 2000 (Table 3). Although the species has disappeared from some historical locations due to habitat destruction, the large number of extant sites suggests that the species was historically widespread. The smaller number of historical records (Table 1, Table 2) is undoubtedly due, at least in part, to the lack of surveys for *E. wolfii* prior to 1978 or due to the lack of field experience of many botanists with the species. This conclusion is supported given: a) the large number of discoveries of this species since 2000 (Table 1, Table 3), b) plants are apparently long lived and individual populations may exist for hundreds of years (Phillippe 2005), c) the species occurs in a wide variety of habitats (see below), and d) there is an abundance of unsurveyed habitat, it is likely that additional populations will be found with further survey efforts.

Habitat requirements and soil types

Eleocharis wolfii has been documented from a wide variety of habitats including: "wet depressions of bottomland and mesic upland prairies;" "wet, open sites;" "wet river and lake margins;" "marshes and seeps;" "ephemeral pools in open grasslands;" "limestone barrens;" "oak flatwoods or woodlands on river terraces;" wet depressions, pond and river margins; wet sand prairies; wet meadows and other moist areas (Kolstad 1986; Godfrey & Wooten 1979; Hedge et al. 1994; Robertson & Phillippe 1992; Eilers & Roosa 1994; Swink & Wilhelm 1994; Yatskievych 1999; Smith. 2002; Diggs et al. 2006). *Eleocharis wolfii* has recently been discovered in wet areas on sandstone glades in Arkansas and Missouri and in wet saline barrens and in wet areas within shale glades in Arkansas (Witsell & McKenzie, pers. obs., 2000–2008). In Georgia, *E. wolfii* is known from ephermal pools on granite outcrops [Tom Patrick, GA Natural Heritage Program (NHP), pers. comm. 2006] and from shallow depressions on sandstone, gneiss granite, and Sioux quartzite in Minnesota [Fred Harris, Minnesota Department of Natural Resources (DNR), pers. comm. 2007].

We could find limited information on soil types associated with the natural communities where *E. wolfii* is currently extant. Prairies in northern Illinois are open, wet and are on poorly to somewhat poorly drained soils that are nearly level or depressional on outwash plains. These soils are often ponded in spring and are dark gray and friable fine sand or sandy loam (Phillippe 2005). At prairie sites in southern Illinois, the soil type is categorized as deep gray silt loam or gray silt loam on tight clay (Robertson & Phillippe 1992). River terraces of southern Illinois flatwoods are on poorly drained silt loam and silty clay loam soils (Miles 1988; Phillippe 2005). In northern Indiana, most populations of *E. wolfii* occur on wet, acidic sandy loam (Hedge et al. 1994). In southern Indiana, the species is found on slowly permeable silt loam (Aldrich & Homoya 1984; Homoya pers. obs. 1983–1993). In Kansas, prairie soils where Wolf's spike-rush occurs range from hard-pan clay, to shallow calcareous soils over limestone, to sandy soils over sandstone (Morse, pers. obs.). Poorly drained sodic and non-sodic silt loam soils are characteristic of Louisiana *E. wolfii* stations (Edwards et al. 1991; Martin et al. 1981). A site in Juneau County, Wisconsin is described as "...moist,

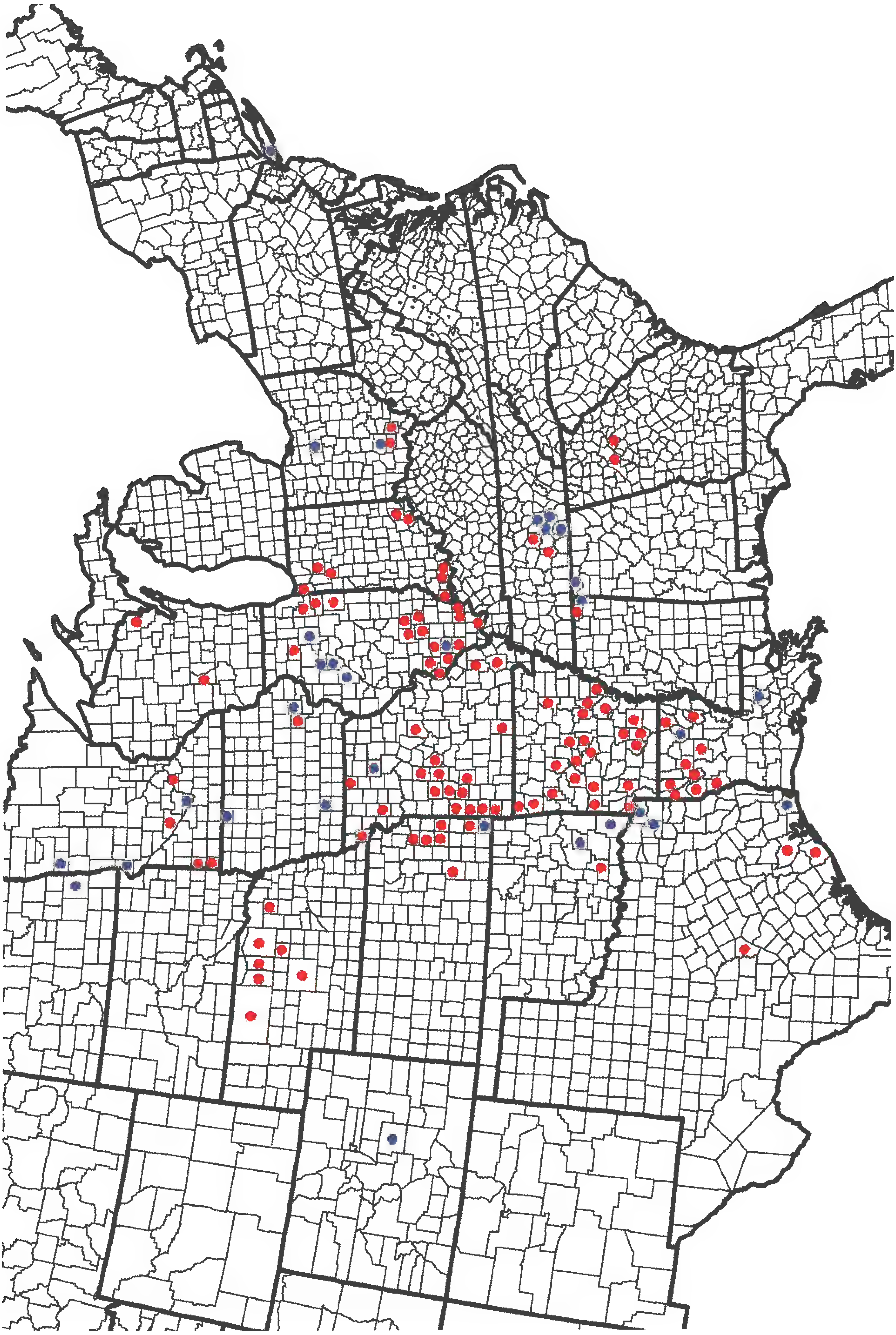


Fig. 3. County distribution map for *E. wolfii* in the United States (blue = historical; red = extant; since 1978).

Table 1. Number of documented historical (prior to 1978) vs. extant sites for *Eleocharis wolfii* in the United States.

State	No. of historical counties/parishes	No. of historical sites	No. of extant counties/parishes	No. of extant sites
AL	1	1	0	0
AR	2	2	22	54
CO	1?	1?	0	0
GA	0	0	2	4
IA	4	4	1	1
IL	9	21	16	47
IN	1	2	8	15
KS	1	1	6	10
LA	2	3	9	14
MN	3	3	4	5
MS	1	1	1	1
MO	2	2	18	30
NE	1	1	7	29
NY	1	1	0	0
ND	1	2	0	0
OH	2	2	2	1
OK	2	2	1	1
TN	4	6	2	2
TX	4?	2?	3	6
WI	1	1	2	2
TOTAL	**43**	**59**	**104**	**222**

Table 2. County/Parish records of *Eleocharis wolfii* known only from historical collections ($n = 31$).

State	Historical counties
AL	Lauderdale
CO	El Paso?
IL	Fulton, LaSalle, Peoria, Perry, Stark
IA	Cedar, Emmett, Union
KS	Cherokee
LA	East Baton Rouge, Ouachita
MN	Nicollet, Norman, Traverse
MO	Linn
MS	Tishomingo
ND	Cass
NY	Nassau
OH	Crawford, Ross
OK	Latimer, McCurtain
TN	Coffee, Franklin, Grundy, Warren
TX	Bowie, Jefferson, Morris

Table 3. Number of documented new sites and counties/parishes for *Eleocharis wolfii* discovered in the United States since 2000.

State	No. of new counties/ parishes	No. of new sites
AR	19	53
GA	1	1
IA	1	1
IL	3	7
KS	5	9
LA	7	11
MN	4	5
MO	16	29
MS	1	1
NE	3	10
OH	1	1
OK	1	1
TN	0	1
TX	1	4
WI	1	1
TOTAL	**64**	**135**

slightly peaty, dark gray fine sandy loam, prob, slightly acid" (http://www.botany.wisc.edu/cgi-bin/specimen.cgi?Accession=v0008579WIS).

Associated species

Due to the wide range of habitats recorded for *E. wolfii*, the list of plant species associated with the species is extensive and there are data from most states within its range. At *Quercus palustris* Muenchh. and *Q. stellata* Wangenh. flatwoods sites in southern Illinois common associates include *Carex annectens* (E.P. Bicknell) E.P. Bicknell var. *xanthocarpa* (E.P. Bicknell) Wiegand, *C. bicknellii* Britton, *C. caroliniana* Schwein., *C. squarrosa* L., *Cinna arundinacea* L., *Eleocharis verrucosa* (Svenson) L.J. Harms, *Galium obtusum* Bigel., *Isoëtes melanopoda* Gay & Dur. and *Q. bicolor* Willd. (Phillippe 2005).

In the wet sand prairies of northern Illinois, *E. wolfii* is associated with *Agalinis purpurea* (L.) Pennell, *Andropogon gerardii* Vitman, *Carex buxbaumii* Wahl, *C. haydenii* Dewey, *C. stricta* Lam., *C. suberecta* (Olney) Britt., *Eleocharis verrucosa*, *Eupatorium perfoliatum* L., *Hypericum adpressum* Bart., *Hypericum sphaerocarpum* Michx., *Leersia oryzoides* (L.) Swartz, *Osmunda regalis* L., *Paspalum laeve* Michx., *Platanthera flava* (L.) Lindl. var. *herbiola* (R. Br.) Luer, *Polygonum careyi* Olney, *Populus tremuloides* Michx., *Rhynchospora capitellata* (Michx.) Vahl, *Rubus schneideri* Bailey, *Sisyrinchium atlanticum* E.P. Bicknell, *Verbena hastata* L., *Viola lanceolata* L., and *Viola primulifolia* L. (Phillippe 2005).

At prairie sites in northern Indiana, associates listed include *Alisma* sp., *Carex lasiocarpa* Ehrhart, *Cyperus bipartitus* Torr., *C. strigosus* L., *Drosera* sp., *Echinochloa crus-galli* (L.) P. Beauv., *Eleocharis elliptica* Kunth, *E. ovata* (Roth.) Roem. & Schult., *E. palustris* L., *Galium obtusum*, *Juncus acuminatus* Michx., *J. brachycarpus* Engelm., *J. dudleyi* Wiegand, *Lysimachia quadrifolia* Sims, *Onoclea sensibilis* L., *Panicum rigidulum* Bosc ex Nees, *Poa pratensis* L., *Polygala sanguinea* L., *Rotala ramosior* (L.) Koehne, *Spartina pectinata* Link, *Spirea alba* Duroi, and *Viola lanceolata* (Robertson & Phillippe 1992: Appendix 1; Phillippe 2005: Appendix 2).

Swink and Wilhelm (1994) also listed the following associates for sites in northeastern Illinois and northwestern Indiana: *Agrostis gigantea* Roth., *Bidens trichosperma* (Michx.) Britton, *Calamagrostis canadensis* (Michx.) P. Beauv., *Carex conoidea* Schkuhr ex Willd., *C. pellita* Muhl. ex Willd., *Cornus amomum* Mill. ssp. *obliqua* (Raf.) J.S. Wilson, *Doellingeria umbellata* (Mill.) Nees, *Eleocharis erythropoda* Steud., *Erigeron philadelphicus* L., *Eryngium yuccifolium* Michx., *Euthamia gymnospermoides* Greene, *Hierochloë odorata* (L.) P. Beauv., *Hedyotis caerulea* (L.) Hook., *Hypericum mutilum* L., *Hypoxis hirsuta* (L.) Cov., *Iris virginica* L. var. *shrevei* (Small) E.S. Anderson, *Juncus marginatus* Rostkov, *J. tenuis* Willd., *Lechea tenuifolia* Michx., *Lobelia spicata* Lam., *Lycopus rubellus* Moench, *Panicum virgatum* L., *Populus deltoides* Bartram ex Marshall, *Rhamnus frangula* L., *Rubus flagellaris* Willd., *Salix humilis* Marshall, *Saxifraga pensylvanica* L., *Thelypteris palustris* Schott var. *pubescens* (G. Lawson) Fernald and *Veronica peregrina* L.

In flatwoods in southwestern Indiana, associates include *Carex annectens, C. muskingumensis* Schwein., *Eleocharis tenuis* (Willd.) Schult., *Isoëtes melanopoda, Ludwigia palustris* (L.) Elliott, *Quercus bicolor, Q. pagoda* Raf., *Q. palustris Q. stellata,* and *Ranunculus pusillus* Poiret (Aldrich & Homoya 1994).

In Kansas, *E. wolfii* has been observed with *Carex annectens, C. festucacea* Schkuhr ex Willd., *C. frankii* Kunth, *C. granularis* Muhl. ex Willd., *C. missouriensis* P. Rothr. & Reznicek, *C. scoparia* Schkuhr ex Willd., *Eleocharis erythropoda, E. macrostachya* Britton, *Glyceria striata* (Lam.) Hitchc., *Juncus acuminatus, J. interior* Wiegand, and *Elymus smithii* (Rydb.) Gould in swales of native tall grass prairie and in disturbed wet prairies. In the floodplain of the Marais des Cygnes River in Linn County, the species was observed along the edge of a field adjacent to a pin oak-hickory-pecan forest remnant (Morse, pers. obs.).

Associated species at Missouri flatwood sites include *Carex scoparia, C. triangularis* Boeck., *C. tribuloides* Wahlenb., *Eleocharis verrucosa, Isoëtes melanopoda, Juncus* spp., *Ludwigia peploides* (Kunth) Raven, *Steinchisma hians* (Elliott) Nash, and *Polygonum* spp. (McKenzie & Jacobs 2000). At Missouri prairie swale sites, *E. wolfii* is often associated with *Carex annectens, Carex bicknellii, C. oklahomensis Mack., C. tribuloides, Dichanthelium scoparium* (Lam.) Gould, *Eleocharis palustris, E. verrucosa, Glyceria striata, Juncus* spp., *Muhlenbergia* spp., *Penstemon tubiflorus* Nutt., *Physostegia virginiana* (L.) Benth., *Scirpus atrovirens* Willd., *S. pendulus* Muhl. ex Elliott, *Sporobolus heterolepis* (A. Gray) A. Gray and *Tripsacum dactyloides* (L.) L. (McKenzie & Jacobs 2000). Other species recorded at prairie sites in Missouri include *Carex conoidea, C. granularis, C. trichocarpa* Muhl. ex Willd., *Carex vesicaria* L.var. *monile* (Tucker.) Fernald, *Carex vulpinoidea* Michx., *Lysimachia* sp., *Lythrum alatum* Pursh, *Platanthera lacera* (Michx.) G. Don, *Polygonum amphibium* L., *Scutellaria galericulata* L., and *Spartina pectinata* (pers. obs.).

In Nebraska, associates recorded for *E. wolfii* include *Agrostis gigantea, Alisma triviale* Pursh, *Apocynum cannabinum* L., *Carex atherodes* Sprengel, *C. buxbaumii, C. emoryi* Dewey, *C. interior* L.H. Bailey, *C. pellita, C. sartwellii* Dewey, *C. scoparia, Dichanthelium acuminatum* (Sw.) Gould & C.A. Clark, *Dulichium arundinaceum* (L.) Britton, *Eleocharis acicularis, E. elliptica, E. erythropoda, E. palustris, Equisetum arvense* L., *Eriophorum polystachion* L., *Euthamia gymnospermoides, Juncus marginatus, J. torreyi* Cov., *Lysimachia hybrida* Michx., *L. thyrsiflora* L., *Lycopus americanus* Muhl., *Phalaris arundinacea* L., *Polygonum amphibium, Pycnantheum virginianum* (L.) T. Durand & B.D. Jackson ex Rob & Fernald, *Salix eriocephala* Michx., *S. exigua* Nutt., *S. humilis, S. petiolaris* Smith, *Sorghastrum nutans* (L.) Nash, *Spartina pectinata, Symphyotrichum lanceolatum* (Willd.) G.L. Nesom, *Spiranthes cernua* (L.) Rich., *Thelypteris palustris* Schott var. *pubescens* (G. Lawson) Fernald, *Triglochin maritima* L. var. *elata* (Nutt.) A. Gray, *Typha angustifolia* L., and *Verbena hastata* L. (Robert Steinauer, pers. comm. 2007).

In Arkansas, *E. wolfii* occurs with *E. verrucosa, Isoëtes melanopoda, Juncus* spp., *Rhynchospora* spp., *Steinchisma hians* on saline barrens; *Carex albolutescens Schwein., C. oklahomensis, C. opaca* (F.J. Herm.) P.E. Rothr. & Reznicek, *Dichanthelium dichotomum* (L.) Gould subsp. *roanokense* (Ashe) Freckmann & Lelong, and *Ranunculus laxicaulis* Darby in prairie swales; *Allium canadense* L. var. *mobilense* (Regel) Ownbey, *E. lanceolota* Fernald, *E. verrucosa, Isoëtes butleri* Engelm., *I. melanopoda, Juncus secundus* P. Beauv. ex Poir., *Ludwigia palustris, Sporobolus ozarkanus* Fernald, and *Steinchisma hians* on shale barrens; *Eleocharis lanceolata, E. verrucosa, Eriocaulon koernickianum* Van Heurck & Müll. Arg. in Van Heurck, *Isolepis pseudosetacea* (Daveau) Gand., *Juncus secundus, Rhynchospora recognita* (Gale) Kral and *Utricularia subulata* L. on sandstone glades; *Carex albolutescens, C. complanta* Torr. & Hook., *C. debilis* Michx. var. *debilis, C. flaccosperma* Dewey, *Fraxinus pennsylvanica* Marshall, *Juncus coriaceus* Mack., *Leersia virginica* Willd., *Liquidambar styraciflua* L., *Quercus lyrata* Walter, and *Q. phellos* L. in flatwoods; and *Cyperus* spp., *Eleocharis* spp, and *Fimbrisylis autumnalis* (L.) Roem. & Schult. on a wet salt lick (Witsell, pers. obs.).

Associates listed at recently discovered sites in Minnesota include *Alopecurus carolinianus* Walter, *Eleocharis acicularis, E. compressa* Sullivant, *E. ovata, Hordeum jubatum* L., and *Juncus interior* (Fred Harris, MN DNR, pers. comm. 2007).

Associates of *E. wolfii* in small depressions of sodic flatwoods and prairies in Louisiana include *Quercus similis* Ashe and *Crataegus brachyacantha* Sarg. & Engelm. in the flatwoods overstory, with herbaceous associates consisting of *Carex annectens, C. aureolensis* Steud., *C. complanata, C. reniformis* (L.H. Bailey) Small, *Cyperus pseudovegetus* Steud., *Dichanthelium scoparium, Eleocharis verrucosa, Juncus marginatus,* Juncus spp., *Iva annua* L., *Ludwigia linearis* Walter, *L. glandulosa* Walter, *Panicum rigidulum, Rhynchospora corniculata* (Lam.) A. Gray, *R. globularis* (Chapm.) Small var. *globularis, Steinchisma hians,* and *Tridens strictus* (Nutt.) Nash. Nonsodic poorly drained flatwoods supporting *E. wolfii* have *Quercus phellos* and *Fraxinus pennsylvanica* in the overstory with an understory supporting *Boltonia diffusa* Elliott, *Campsis radicans* (L.) Bureau, *Carex complanata, C. lurida* Wahlenb., *C. triangularis, Dichanthelium dichotomum* var. *dichotomum, D. scoparium, Euthamia leptocephala* (Tor. & A. Gray) Greene ex Porter & Britton, *Helenium flexuosum* Raf., *Juncus coriaceus* Mack., and *Steinchisma hians*. The moss genus *Climacium* F. Weber & D. Mohr is often characteristic of shaded sites supporting *E. wolfii* in Louisiana and Reid has used the presence of this moss with success to locate *E. wolfii*. *Sphagnum* L. is also an occasional associate in Louisiana.

Population estimates

Other than very rough estimates, there are limited detailed demographic data available on Wolf's spike-rush at most sites in North America. Robertson and Phillippe (1992), however, closely examined two large populations of *E. wolfii* in southern Illinois (one from a prairie swale habitat and the second from a *Quercus* spp. flatwoods) and counted the number of tufts or clumps, the number of stems/tuft, and fruiting stems within eight randomly selected ¼ m^2 circular plots. They also counted spikelet scales and achenes from 50 randomly selected spikelets and obtained an estimate on fruit set. The total area of the prairie population was 321.4 m^2 and that of the flatwoods population was about 3,380 m^2. Measurements from the prairie population plots yielded 1,108 tufts and 5,059 stems, of which 1,807 (36%) were fruiting. By extrapolation, this population contained 178,078 tufts, 813,082 stems and 290,421 fruiting culms. The 50 spikelets produced an average of 22 scales and 10 achenes per spikelet. This yielded a total estimate of 6,389,262 scales, about 2,904,210 achenes, and a fruit set of approximately 45%. Similar procedures were performed for the flatwoods site except that 100 spikelets were collected to calculate fruit set data. The 100 spikelets produced an average of 25 scales and 14 achenes per spikelet. This yielded a total estimate of 13,308,750 scales, about 7,452,900 achenes, and a fruit set of approximately 56%.

In a second population examined in Washington County (Robertson & Phillippe 1992: collection-Phillippe & Gehlhausen 20311), results were substantially different. This population was located at an ephemeral pool surrounded by *Quercus palustris* in a *Q. stellata* flatwoods. The *Q. stellata* crowns nearly covered the ephemeral pool such that the *E. wolfii* population had low available light. The population was in an area of 122.6 m^2 and 33% of the site was surveyed. Robertson and Phillippe (1992) extrapolated that the total area had 1,167 tufts with a total of 5,400 stems, of which only 228 (4%) of the stems were fruiting. Rough estimates at other localities have been reported as few as 25 culms and as high as hundreds of thousands of plants (Robertson & Phillippe 1992; McKenzie & Jacobs 2000; Fred Harris, MN DNR, pers. comm. 2006). We could not find any gray or published literature on seed viability, predation, or germination requirements for Wolf's spike-rush.

Conservation status

Phillippe (2005) conducted a conservation assessment on the species for the Eastern Region of the U.S. Forest Service but his report only covered Illinois and Indiana. NatureServe (2009) listed global and state ranks outlining the global rarity and conservation status of *E. wolfii* in each state in the United States. *Eleocharis wolfii* currently has a global rank of G3G4 (NatureServe 2009). A G3 ranking indicates that a species is vulnerable globally due to a limited distribution and potential threats to its continued existence. A species ranked G4 is one that is generally uncommon and widespread but apparently secure. The GRANK for *E.wolfii* was reviewed in 2006 in light of recent discoveries outlined in this report (Leah Oliver, NatureServe, pers. comm. 2006). NatureServe (2006) SRANK categories included SH (historical with the expectation that it still may be extant and possibly rediscovered), S1 (critically imperiled), S2 (imperiled), S3 (vulnerable), S4 (apparently secure), and SNR/SU (not ranked/under review). States and NatureServe (2009) SRANKs listed for Wolf's spike-rush are: Alabama (S1), Arkansas (S3), Georgia (S1), Illinois (S1), Indiana (S2), Iowa (S1), Kansas (S2), Louisiana (S3), Minnesota (S1), Missouri (S3S4), Mississippi (SU/NR), Nebraska (S2), North Dakota (SH), Ohio (S1), Oklahoma (SU/NR), Tennessee (S1), Texas (S1), Virginia (S1), and Wisconsin (S1) (Louisiana Natural Heritage Program 2009; NatureServe 2006, 2009; Tim Smith, Missouri Department of Conservation, pers. comm. 2005).

In some states, *E. wolfii* is given special designations separate from the NatureServe ranking. Wolf's spike-rush is listed as an endangered species in Minnesota, Ohio, Tennessee, and Wisconsin, rare in Indiana, a species of special concern in Arkansas, Georgia, and Iowa, and a species of uncertain status in Virginia (Appendix 1). Separate state designations are not provided for *Eleocharis wolfii* in Alabama, Illinois, Kansas, Louisiana, Mississippi, Missouri, North Dakota, Oklahoma, or Texas (Appendix 1).

In Nebraska, *E. wolfii* is listed as a Tier 1 At-Risk Species as part of the Nebraska Game and Parks Commission's Natural Legacy Project (Nebraska Game & Parks Commission 2009a). This program is part of the state's development of a Comprehensive Wildlife Strategy that has been initiated in all 50 states (Nebraska Game & Parks Commission 2009b). *Eleocharis wolfii* is included on the U.S. Forest Service's regional forester sensitive plant list (Phillippe 2005; U.S. Department of Agriculture 2006).

Wilhelm (1977, 1978) developed a system to assess how conservative various plant taxa were in Kane County, Illinois by giving each species a "coefficient of conservatism." Species with the least conservative value were ranked as 0 while those with the highest conservative rating were graded as 10. This system was adopted and modified by Swink and Wilhelm (1979), and further refined by Wilhelm and Ladd (1988). The methodology was summarized by Swink and Wilhelm (1994) and Taft et al. (1997). Swink and Wilhelm (1994) provided coefficients of conservatism for each plant species in the Chicago Region. *Eleocharis wolfii* was given the highest conservative rank of 10 and was listed as a representative of high quality wet prairies (Swink and Wilhelm 1994). In other states in the Midwest, however, the coefficient of conservatism ranges from 5–9 for Wolf's spike-rush.

State accounts

Alabama.—Smith (2002) listed Alabama within the range of *E. wolfii* and the species is known from a sole historical record from Lauderdale County (Al Schotz, AL NHP, pers. comm. 2009).

Arkansas.—Historically, Wolf's spike-rush was only known from two specimens with vague locality data from Arkansas and Little River counties (Table 1, Table 2). Recent surveys by Witsell, McKenzie, and others in Arkansas from 2002 to 2008 have yielded 54 new sites that are widely distributed among 22 counties, including the two historical counties (Table 1, Table 3, Fig. 3). In Arkansas *E. wolfii* is found in a wide variety of natural, historically open, wet to seasonally wet habitats. These habitats include unplowed tallgrass prairies, saline barrens, sandstone glades, shale barrens, open hydric pine flatwoods dominated by *Pinus taeda*, open hydric oak-dominated flatwoods, forested channel scar wetlands on abandoned stream terraces in the Ouachita Mountains, and a seasonally wet deer-maintained salt lick. *Eleocharis wolfii* may also occasionally occur in ditches along roads that cut through these habitats.

Colorado.—Although Smith (2002) stated that he had not seen specimens of *E. wolfii* to verify literature reports of the species in Colorado, Martin (1993) listed a record from El Paso County and noted that the specimen had been cited by Svenson. However, Svenson was unaware of *E. acicularis* var. *porcata* and misidentified specimens of this taxon for *E. wolfii* (Smith 2001a, 2002). Surveys in Colorado will be needed to assess the current status of *E. wolfii* in the state.

Georgia.—Wolf's spike-rush is currently known from three sites in Walton County and one site in DeKalb County (Jim Allison, and Tom Patrick, GA NHP, pers. comm. 2006).

Illinois.—The type locality for Wolf's spike-rush is Fulton County, Illinois (Gray 1874; Mohlenbrock 1976; Phillippe 2005) and the species has undoubtedly received more attention in this state than any other within its range. Robertson and Phillippe (1992) conducted an extensive survey for *E. wolfii* in Illinois and documented 26 populations in 11 counties. Of these, nine populations were documented from four counties and the species was collected from ephemeral pools of remnant native prairie habitat. An additional 17 populations were recorded across seven counties and were found in ephemeral pools within open oak flatwoods on river terraces (Robertson and Phillippe 1992). In Illinois *E. wolfii* often occurs in large colonies that range from "several hundred to many thousands of culms," and these populations may cover a "few hundred m^2 to a few thousand m^2 area" (Phillippe 2005; Phillippe, pers. obs.). Since 1978, *E. wolfii* has been documented from approximately 47 sites in 16 counties in Illinois (Table 1, Fig. 3).

Indiana.—*Eleocharis wolfii* was first collected in Indiana in 1935 by F.J. Hermann and C.C. Deam at apparently two separate sites (Phillippe 2005). There are currently 15 extant occurrences scattered across Lake, Pulaski, and White counties in northern Indiana and from Jefferson, Posey, Ripley, Spencer, and Warrick counties in southern Indiana (Swink and Wilhelm 1994; Phillippe 2005; Table 1, Fig. 3). Habitat for the species in Indiana is identical to that recorded for Illinois (Phillippe 2005; Indiana Natural Heritage Data Center 2009). *Eleocharis wolfii* occurs along ephemeral pools in *Quercus palustris* flatwoods in southern Indiana and is associated with wet, sandy prairies in the northern portions of the state.

Iowa.—There are four historical records for the state: one each for Cedar, Emmet, Johnson and Union counties (Eilers & Roosa 1994). The only known extant site occurs on the Williams Prairie State Preserve in Johnson County (Table 1, Fig. 3). The species was found during a floristic inventory of Williams Prairie in 2002 (John Pearson, Iowa DNR, pers. comm. 2009).

Kansas.—Wolf's spike-rush was collected as early as 1897 in Cherokee County, but not again in the state until 1986, when a specimen was taken in Crawford County (C. Freeman, pers. comm.). Since 2000, *E. wolfii* has been documented to occur at nine additional sites in Anderson, Douglas, Franklin, Linn, and Greenwood counties. The species is known in Kansas only from the eastern one-quarter of the state, where it has been observed in swales in upland prairies over both limestone and sandstone soils, in roadside ditches and disturbed wet prairies adjacent to higher quality sites, and in a disturbed, cool-season grassland adjacent to remnant bottomland pin oak-hickory-pecan forest (Table 1, Fig. 3).

Louisiana.—Historically, *E. wolfii* was collected from three localities at one site each in East Baton Rouge, Franklin, and Ouachita Parishes (= counties) between 1931 and 1970. Surveys conducted in 2007 and 2008 by Reid led to the discovery of 14 new sites in nine parishes that included seven new parish records. Previous reports recorded for Natchitoches, Richland, St. Martin, and St. Tammany Parishes proved to be misidentifications of other species, namely *Eleocharis acicularis* and *E. montevidensis* Kunth. In Louisiana, Wolf's spike-rush is found in depressions in flatwoods and saline prairies, broader wet flatwoods, and in ditches within these habitats. Several flatwoods records are from utility corridors where some portion of the native herbaceous component persists. Much of this herbaceous layer is shaded out by dense stocking of adjacent forests, due to fire exclusion or by other types of management (e.g., *Pinus taeda* L. plantations).

Minnesota.—*Eleocharis wolfii* is currently known from five extant sites in four counties (Pipestone, Renville, Rock, Scott) and the species was historically known from three additional sites in three separate counties (Nicollet, Norman, Traverse). The species is found in shallow swales over Jordan Sandstone, along margins of shallow depressions in gneiss bedrock along the Minnesota River, and in prairie swales and ephemeral pools of exposed Sioux Quartzite outcrops (Fred Harris and Welby Smith, Minnesota DNR, pers. comm. 2006, 2007). Population estimates at extant sites range from 50 to 10,000s of plants (Harris, pers. comm. 2007).

Mississippi.—*Eleocharis wolfii* was historically known from one site in Tishomingo County and was considered likely extirpated in the state until it was rediscovered in Alcorn County in 2008 by Charles Bryson (Bryson, pers. comm. 2008).

Missouri.—Wolf's spike rush was previously known in Missouri solely from collections taken in Linn and Callaway counties (Steyermark 1963; Yatskievych 1999). Even with repeated searches to document its occurrence in Missouri, the species had not been observed in recent years and was believed to be possibly extirpated from the state (Yatskievych 1999). The species was rediscovered in 1999 along the edge of a seasonally-flooded bottomland forest in Stoddard County, in the Missouri Bootheel (McKenzie and Jacobs 2000). Subsequent to this discovery, the species was documented in wet swales of five high quality prairies in southwest Missouri, in early June 1999 (McKenzie and Jacobs 2000). In 2000, a second location was documented in seasonally-flooded bottomland in Stoddard County (Smith 2001b). Between 2000 and 2008, Wolf's spike-rush was discovered at 21 additional prairie sites at scattered localities in northern and southern Missouri and was rediscovered at its historical location in Callaway County. *Eleocharis wolfii* was discovered on a sandstone glade in Henry County in 2003 (Missouri Natural Heritage Database 2009). Currently Wolf's spike-rush is known from 30 localities scattered throughout 18 counties (Fig. 3). Most localities occur within the Unglaciated Plains Division (Thom & Wilson 1980, 1983; Yatskievych 1999) of southwestern Missouri but there are a few records from the Glaciated Plains (Thom & Wilson 1980, 1983; Yatskievych 1999) of central and northern Missouri and the Mississippi Lowlands (Thom & Wilson 1980, 1983; Yatskievych 1999) in extreme southeastern Missouri. Due to the numerous recent discoveries, the species is no longer being tracked as a species of conservation concern (Missouri Natural Heritage Program 2009).

Nebraska.—*Eleocharis wolfii* was first collected in Brown County in 1890 by J. Bates. Based on misidentification of *E. acicularis*, Wolf's spike-rush was deleted from the Nebraska list (Rolfsmeier 1995), but was subsequently reconfirmed after a collection by Rolfsmeier in 1996 in Cherry County (Rolfsmeier & Steinauer 1999). Rolfsmeier and Robert Steinauer collected the species in Garfield and Rock counties, respectively, in 1999. Steinauer subsequently documented *E. wolfii* from 10 sites between 2000 and 2005 while conducting surveys for *Platanthera praeclara* Sheviak & Bowles and *Schoenoplectus hallii* (A. Gray) S.G. Sm. in the eastern Sandhills of Nebraska, and discovered an additional 14 new sites on the Valentine National Wildlife Refuge in Cherry County in 2006 (Steinauer, pers. comm. 2007). Currently, *E. wolfii* is extant at 29 sites scattered across seven counties in the northern one-half of Nebraska (Table 1; Fig. 3). Because it has been estimated that there are 19,300 square miles (Knue 1997) of sandy habitat within the sandhills region of the state, ongoing surveys are likely to yield additional new populations of this species.

New York.—*Eleocharis wolfii* is known solely from historical collections taken in 1927 from an open, wet meadow adjacent to a train station on Long Island (Nassau County) (Troy Weldy, NY NHP, pers. comm. 2006). The population is now extirpated and is considered by most to be adventive (Svenson 1957; Troy Weldy, pers. comm.).

North Dakota.—Martin (1993) listed two sites from Cass County, North Dakota. Kolstad (1986) and Smith (2002) included the state within the range of *E. wolfii*. One site was known from a roadside ditch and another site has since been destroyed by development (Justin Parks, ND NHP, pers. comm. 2006). Wolf's spike-rush is considered possibly extirpated from North Dakota (Parks, pers. comm. 2006; NatureServe 2009).

Ohio.—There is one extant site for *E. wolfii* in Ohio on a TNC preserve in Jackson County and adjacent Pike County that was initially discovered in 1993 (Rick Gardner, Ohio DNR, pers. comm. 2009). There are also two historical collections taken from remnant prairies in Ross County (1945) and Crawford County west of Monnett (1953). The site in Ross County has been largely destroyed and apparently no longer supports *E. wolfii*. Although the exact location of the historical collection in Crawford County can not be determined, it is possible that it was taken from a high quality prairie that was converted to cropland in 1963 (Gardner, pers. comm. 2009). The single extant population on the TNC preserve is apparently increasing due to good management (Gardner, pers. comm. 2009).

Oklahoma.—In Oklahoma, *E. wolfii* was historically known from two collections: one taken by F.H. Means, Jr. in Latimer Co., 1968 (KANU collection) and one collected in 1969 by U.T. Waterfall from a wet prairie in McCurtain County (Amy Buthod, OK NHP, pers. comm. 2006). There have been no subsequent surveys for the species in the state (Bruce Hoagland, University of Oklahoma, pers. comm. 2007). However, in 2008, Jason Singhurst collected *E. wolfii* in Atoka County from TNC's Boehler Seeps and Sandhills Preserve where it was growing in a sandy hillside seepage bog (Singhurst, pers. comm. 2009). This record apparently represents the only known extant population in the state.

Tennessee.—Wolf's spike-rush is known historically from seven sites in five counties: (Coffee, Franklin, Grundy, Rutherford, Waren) (Table 1, Fig. 3) but currently only extant at one site each in Marshall and Rutherford counties (Roger McCoy, Tennessee Division of Natural Areas, pers. comm. 2007). A new site was discovered in 2003 in Rutherford County, but the site is threatened by construction and a new housing subdivision. Construction activities possibly altered the hydrology of the site and the *E. wolfii* was being displaced by species more typical of upland localities when visited in 2005 (McCoy, pers. comm. 2007).

Texas.—The status of reports of *E. wolfii* recorded for Texas is unclear. Diggs et al. (2006) listed the species for Bowie, Burnet, Jefferson and Morris counties, but Barney Lipscomb was only able to locate specimens for Bowie County (Botanical Research Institute of Texas [BRIT], pers. comm. 2007). S.Galen Smith has seen specimens of Wolf's spike-rush from Burnett and Jefferson counties (Smith pers. comm. 2007). David Rosen of Lee College in Baytown, Texas has collected the species from four separate sites in Brazoria County between 2004 and 2005 (Lipscomb, pers. comm. March 2007; Rosen 2007; Rosen, pers. comm. 2007). Smith noted a specimen taken by Crockett in 1944 from Beaumont, Texas, but was unsure from what county the specimen was taken (Smith pers. comm. 2007). We suspect that it is from Jefferson County. Martin (1993) listed a specimen from Harris County but neither Smith nor Lipscomb has confirmed the identification (Lipscomb and Smith pers. comm. 2007). A recent specimen collected by Jason Singhurst confirms the presence of *E. wolfii* in Harris County (pers. comm. 2009). Recent collections in Brazoria County by Rosen strongly suggest that additional survey efforts in this state are warranted. Several saline prairies/barrens were recently identified in Harrison, Marion, and Panola Counties in northeast Texas, and have received some preliminary botanical exploration (M. MacRoberts, pers. comm. 2009 and J. Singhurst, pers. comm. 2009). Given that *E. wolfii* occurs in this habitat in adjacent Caddo and De Soto Parishes, Louisiana, it will likely be found in this part of Texas.

Wisconsin.—*Eleocharis wolfii* was recently rediscovered in Wisconsin (Smith 2002) and the only extant records of the species in the state are from one site each in Juneau and Marinette counties (Craig Anderson, WI NHP, pers. comm. 2007; Galen Smith, pers. comm. 2007). There is also one historical collection taken from Juneau County. Habitat in Juneau County is a sedge and grass-dominated meadow swale between a roadside and adjoining swampy woods (http://www.botany.wisc.edu/cgi-bin/specimen.cgi?Accession=v0008579WIS) (Anderson, pers. comm., 2007).

Summary of threats

A. The present or threatened destruction, modification, or curtailment of the species' habitat or range.—Although numerous new populations of *E. wolfii* have been discovered in the United States since 2000, some historical locations have been destroyed and extant populations are subject to various threats. Some historical sites have been eliminated due to the conversion of native prairie and wetland habitat to agricultural crops, the conversion of native prairie to hayfields and pasture, the cutting of many bottomland forests, or the loss of habitat due to residential and commercial development (Turner 1934; Martin 1993; Greenberg 2002; Nelson 2005; Phillippe 2005). Swink and Wilhelm (1994) and Greenberg (2002) summarized the widespread destruction of native prairies and oak savannas near Chicago. Given the extent of native prairie prior to European settlement, the historical range of *E. wolfii* was undoubtedly much more extensive even than recent discoveries in the Midwest and south-central Gulf Coast would suggest.

In Illinois, Robertson and Phillippe (1992) noted that herbicide application at one site in Effingham County killed ca. 90% of the culms of a population discovered five days earlier by Phillippe. The alteration of hydrologic cycles associated with overland flooding was identified as a threat to Wolf's spike-rush in the state by Phillippe (2005).

Due to the immediacy and magnitude of threats to Wolf's spike-rush habitat in Illinois, especially on private property, Robertson and Phillippe (1992) recommended that *E. wolfii* be listed as a threatened species in that state. Despite the large number of extant sites in Illinois (Table 2, Table 3), species experts in that state have recommended that the SRANK for the species be retained as S1.

B. Over-utilization for commercial, recreational, scientific, or educational purposes.—To our knowledge there is no evidence that Wolf's spike-rush is being negatively impacted due to over-utilization for commercial, recreational, scientific, or educational purposes.

C. Disease or predation.—Phillippe (2005) included livestock grazing as a potential threat to populations of *E. wolfii*. Other than possible negative impacts from grazing, we are unaware of any additional threats to the species from disease or predation.

D. The inadequacy of existing regulatory mechanisms.—Although the NatureServe global and state rankings for *E. wolfii* do not provide any regulatory protection for *E. wolfii*, separate designations in some states afford limited regulatory protection for the species.

Nebraska's listing of *E. wolfii* as a Tier 1 At-Risk Species does not provide any regulatory protection status to the species, but the designation has heightened awareness of its management needs and the NE Department of Roads proactively consults with the NE Game and Parks Commission for highway projects that may impact the species (R. Schneider, NE NHP, pers. comm. 2006). *Eleocharis wolfii* can not be collected in the state without a permit (Schneider, pers. comm.).

A state listing as endangered provides little protection for *E. wolfii* in Wisconsin under state statutes 29.604 and NR (Natural Resources) 27.03-NR27.07 (Wisconsin Legislature 2007a, 2007b; Michigan State University 2007). Under Wisconsin law, the taking of *E. wolfii* is prohibited without a permit under section 27.05. Permits are not required, however, for persons who want to take this or other state listed species: 1) on property which they own or lease or for which they have been granted landowner permission, except if the plants or their progeny are sold or processed, 2) on property that is being used for agriculture, construction, or forestry practices, or 3) on property that is being operated or maintained as a utility facility (Michigan State University 2007; Wisconsin Legislature 2007b).

Little protection is afforded *E. wolfii* under Indiana law, but personnel with the Indiana DNR have an opportunity to provide input on state-funded projects that could negatively impact the species. In Georgia, *E. wolfii* is listed as a species of conservation concern (Appendix 1) but it is not listed as a protected species under Georgia state law (http://georgiawildlife.dnr.state.ga.us/content/protectedplants.asp). Region 9 of the U.S. Forest Service includes *E. wolfii* on their regional forester sensitive plant list (Phillippe 2005; U.S. Department of Agriculture 2006) but the designation does not provide any regulatory protection (Dave Moore, USFS, pers. comm., Mar 2009).

E. Other natural or manmade factors affecting its continued existence.—Global warming and climate change could contribute to loss of wetland habitat required by this species by causing droughts to be more extensive and persistent, especially in the Midwest where drought conditions have persisted for several years, and are predicted to continue with increasing frequency in the future (Hansen 1989; Rosenzweig et al. 2000). Climate models indicate that high temperatures and an increase in pests (Rosenzweig et al. 2000) and other invasive species (Vitousek 1994) will accompany the increased frequency of droughts and other extreme events (Dai et al 1996). Global warming and climate change have increasingly been identified as factors which may contribute to the loss of biodiversity and extinction of imperiled species (Wilcove et al. 1998; Thomas et al. 2004; Maschinski et al. 2006). Habitat for *E. wolfii* is likely further threatened due to projected changes in agricultural development, especially corn production that is needed for increasing demands for ethanol production (Keeney and Mueller 2006; U.S. Department of Agriculture 2007). Keeney and Mueller (2006) estimated a 254% increase in volume of water used in ethanol production from 1998 to 2008 for only one state in the Midwest. Corn production for ethanol plants is projected to increase in 2007 by 14.2% in Illinois (U.S. Department of Agriculture 2007), the state with the second largest number of extant sites for Wolf's spike-rush. Nebraska has large areas of potential habitat in its sandhills region (Knue 1997), but Keeney and Mueller (2006) postulated that increasing demand for ethanol production may result in competing water uses in that state. Increased demands for water from above ground sources and underground aquifers could prevent the formation and maintanence of important wetland habitat needed by *E. wolfii* throughout the Midwest.

Research needs

Additional surveys are warranted, especially in states where the species is known only from historical locations believed to have been extirpated. Based on recent discoveries in Arkansas, Louisiana, Missouri, and Nebraska, surveys should be conducted between March and May in the southern U.S. and between May and June in the northern limits of the species' range. Additional research on the life history and ecological requirements would be helpful in identifying areas where additional populations could be discovered. Recent discoveries of *E. wolfii* in previously unrecorded habitats (e.g., sandstone glades in AR and MO, shale glades and saline barrens in AR and LA, shallow depressions in gneiss bedrock in MN) suggests that the species occupies a broader range of habitats than reported by McKenzie and Jacobs (2000), Smith (2002), and Phillippe (2005). Natural community type, soil type, plant associates, and phenology should be recorded at each site. Other than estimates taken at different sites in Illinois by Robertson and Phillippe (1992), we are unaware of any additional reports where attempts were made to calculate different demographic parameters. Further studies on the population dynamics and genetic diversity of this species would be useful in assessing the long-term persistence and conservation status of this species in the future.

Research on seed viability, predation, population genetics and germination requirements for the species is lacking (Phillippe 2005). Phillippe (2005) postulated that gravity and flood water were likely mechanisms for seed dispersal but additional investigations are needed, especially for upland sites. Studies should be initiated to further examine competition and responses by *E. wolfii* to various levels of management and disturbance, especially grazing pressure from native and non-native herbivores. Analyses of land use changes would help researchers assess threats to the species, especially related to the conversion of native habitat for agriculture, silviculture, and residential development. Further evaluations are needed to assess differences in habit, light requirements and reproductive success of individuals of *E. wolfii* in shaded sites vs. localities in full sunlight.

Oak flatwood sites in AR, IL, IN, and MO are dependent upon flood waters or water accumulated from precipitation. The importance of seasonal flooding to the dispersal of *E. wolfii* and its germination requirements should be further studied. What role the increase and spread of invasive species has on *Eleocharis wolfii* should be investigated, particularly in light of possible scenarios associated with predicted impacts from projected changes in climate.

Results of searches conducted by authors of this report suggest that additional populations of Wolf's spike-rush are likely to be found if surveys are conducted in appropriate habitats during the proper season. Prairie swales, including those associated with remnant railroad prairies in IA, IN, MI, MN, ND, OH, OK, and TX should be targeted for surveys. Oak flatwoods in MS, western TN, and southwestern KY may yield additional populations.

Management needs

We can find little information on management recommendations to benefit Wolf's spike-rush. Phillippe (2005) suggested that the maintenance of openings in flatwood habitats, the monitoring of potential impacts of exotic species, and the use of prescribed fire to prevent the encroachment of woody vegetation were treatments that could be useful in maintaining populations of *E. wolfii*. The importance of using prescribed fire to maintain prairie, savannah, and glade habitats has been extensively reported on in the published and gray literature (e.g., Swink & Wilhelm 1994; Davit 1999; Greenberg 2002; Nowacki & Abrams 2008). Prescribed fires not only maintain open habitats and halt the spread of trees and shrubs, but the repeated practice prevents the establishment of fire sensitive species (Phillippe 2005; and exhaustively reviewed in Nowacki & Abrams 2008). Mowing and haying may also be beneficial to the species by helping control woody vegetation, by opening the canopy, and by providing a low level of disturbance necessary for colonization of rhizomes or achene germination.

Phillippe (2005) advised against actions that alter soils where Wolf's spike-rush occurs but the relationship of soil disturbance in maintaining the species' habitat is not fully understood. Bowles et al. (1990)

included *E. wolfii* on a list of species that positively responded to anthropogenic influences of humans at the Indiana Dunes National Lakeshore but Phillippe (2005) believed that the response there was likely due to increased light levels that resulted from the disturbance. Some level of disturbance from natural processes (e.g., fire, flooding) is likely important for achene germination and plant growth of *E. wolfii* but we are unaware of the initiation of any experiments to test this hypothesis. The importance of maintaining natural hydrologic regimes was noted by Phillippe (2005) and NatureServe (2009).

CONCLUSION

Although *E. wolfii* has disappeared from some historical sites across the range of the species and is threatened with various land use changes, the large number of discoveries in the central U.S. between 2000 and 2008 strongly suggest that the species is not as rare as previously believed but has been simply overlooked by botanists who were unfamiliar with the species' habitat requirements and phenology or confused it with other members of the genus. Significant threats to the habitat of *E. wolfii* still persist and, due to potential negative effects associated with climate change, the increased demand for agriculture and ethanol production, and commercial and residential development associated with population growth, we recommend that botanists continue to monitor the status of this species throughout its range. The current NatureServe global rank for this species is G3G4. Although 222 extant sites and populations at some localities numbering in the thousands of individuals may suggest a G4 ranking, *Eleocharis wolfii* remains threatened in many areas. Due to these threats, the range-wide population status is likely somewhere between a G3 and G4. Consequently, we recommend the retention of the current global rank of G3G4. If additional populations are found, however, and/or threats to extant populations are significantly reduced, the global rank of this species should be reassessed at a future date.

APPENDIX 1

Conservation status of *Eleocharis wolfii* in each state where the species has been reported and website link or literature citation for listings.

Alabama–No status; the species is not listed on Alabama's list of species of special concern (Alabama Department of Conservation and Natural Resources 2006). Available at: http://www.outdooralabama.com/watchable-wildlife/regulations/endangeredbycounty.cfm; http://www.auburn.edu/herbarium/teplants.html. Accessed 7 Mar 2009.

Arkansas–Species of conservation concern: *Eleocharis wolfii* is included in the state's list of plants of conservation concern (Arkansas Vascular Flora Committee 2006). *Eleocharis wolfii* is not listed as a protected species under Arkansas state law.

Colorado–No status: Wolf's spikerush is not included on the state's rare plant field guide (Colorado Natural Heritage Program 1999). Available at: http://www.cnhp.colostate.edu/rareplants/masterlist.html#E. Accessed Mar 2009.

Georgia–Species of special concern: in Georgia the species is listed as a plant species of special concern (Georgia Department of Natural Resources 2008). *Eleocharis wolfii* is not listed as a protected species under Georgia state law. Available at: http://georgiawildlife.dnr.state.ga.us/content/specialconcernplants.asp; http://georgiawildlife.dnr.state.ga.us/content/protectedplants.asp; http://www.georgiawildlife.com/documentdetail.aspx?docid=89&pageid=7&category=conservation. Accessed 7 Mar 2009.

Illinois–No status: although Robertson and Phillippe (1992) recommended that *E. wolfii* be included in the Illinois' list of endangered and threatened species, Wolf's spikerush is not currently so listed (Illinois Endangered Species Protection Board 2007). Available at: http://www.dnr.state.il.us/espb/datelist.htm. Accessed 7 Mar 2009.

Indiana–Rare: Wolf's spikerush is listed as ranked as "rare" by the Indiana Department of Natural Resources (Indiana Department of Natural Resources 2007). Available at: http://www.in.gov/dnr/naturepreserve/files/np_spencer.pdf. Accessed 7 Mar 2009.

Iowa–Species of special concern: *Eleocharis wolfii* is included on Iowa's list of "Fragile Flora" (Iowa Department of Natural Resources 2007). Available at: http://fm.iowa.uiowa.edu/fmi/xsl/herbarium/details.xsl. Accessed 7 Mar 2009.

Kansas–No status: *Eleocharis wolfii* is not tracked by the Kansas Parks and Wildlife Department (Kansas Department of Wildlife and Parks 2005). Available at: http://www.gpnc.org/refuge.htm#SPECIES; http://www.kdwp.state.ks.us/news/Other-Services/Threatened-and-Endangered-Species/Threatened-and-Endangered-Species/Statewide-List; http://www.kdwp.state.ks.us/news/content/search?SearchText=endangered. Accessed 7 Mar 2009.

Louisiana–No status: the species is included on the Louisiana Department of Wildlife and Fisheries' list of rare plant species but there is no separate status other than Natural Heritage state rank of S3 (Louisiana Department of Wildlife and Fisheries 2009). Available at: http://www.wlf.louisiana.gov/pdfs/experience/naturalheritage/rareplant/eleocharis%20wolfii.pdf; http://www.wlf.state.la.us/pdfs/experience/naturalheritage/2009%20Rare%20Plant%20Tracking%20List.pdf. Accessed 7 Mar 2009.

Minnesota–Endangered: the Minnesota DNR lists Wolf's spikerush as an endangered species on their Rare Species Guide (Minnesota Department of Natural Resources 2009). Available at: http://www.dnr.state.mn.us/rsg/a-z_search.html?action=a-z Search&letter=E&column=SCIENTIFIC_NAME. Accessed 7 Mar 2009.

Missouri–No status: due to recent discoveries in Missouri, *E. wolfii* is no longer tracked on the state's list of species and communities of conservation concern (Missouri Natural Heritage Program 2009).

Nebraska–No status: in Nebraska, *E. wolfii* is listed as a Tier 1 At-Risk Species as part of the Nebraska Game and Parks Commission's Natural Legacy Project (Nebraska Game & Parks Commission 2009a). This program is part of the state's development of a Comprehensive Wildlife Strategy that has been initiated in all 50 states (Nebraska Game & Parks Commission 2009b). Available at: http://www.ngpc.state.ne.us/wildlife/programs/legacy/about.asp; http://www.ngpc.state.ne.us/wildlife/programs/grants/tier1.pdf. Accessed Mar 2009.

New York–No status: this species is not tracked by the New York Natural Heritage Program (New York Natural Heritage Program 2008). Available at: http://www.dec.ny.gov/docs/wildlife_pdf/nynhprpsl.pdf. Accessed 14 Mar 2009.

North Dakota–No Status: plants are not tracked by the North Dakota Natural Heritage Inventory. Available at: http://www.fs.fed.us/r2/nebraska/gpng/reports/nd_animals_1998.pdf.

Ohio–Endangered: *Eleocharis wolfii* is listed on the state's 2008–2009 list of rare plants (Ohio Division of Natural Areas and Preserves 2008). Available at: http://www.dnr.state.oh.us/Portals/3/heritage/2008-2009%20Ohio%20Rare%20Plant%20List.pdf http://www.dnr.state.oh.us/tabid/2018/default.aspx#Anchor-46443. Accessed 7 Mar 2009.

Oklahoma–No status: the Oklahoma Natural Heritage Inventory does not include Wolf's spikerush on their list of rare and vulnerable plant species for the state (Oklahoma Natural Heritage Inventory 2005). Available at: http://www.oknaturalheritage.ou.edu/plants_rare_vulnerable.htm. Accessed 7 Mar 2009.

Tennessee–Endangered: the species is included on Tennessee's Natural Heritage Program's rare plant list (Tennessee Department of Environment and Conservation. 2008). Available at: http://www.state.tn.us/environment/na/pdf/plant_list.pdf. Accessed 7 Mar 2009.

Texas–No status: Wolf's spikerush is not tracked by the Wildlife Diversity Program of Texas Parks and Wildlife Department as a state threatened or endangered species (Texas Parks and Wildlife Department 2004). Available at: http://www.nature.org/wherewework/northamerica/states/texas/files/listofrareplants.pdf; http://www.tpwd.state.tx.us/huntwild/wild/species/endang/plants/index.phtml. Accessed 7 Mar 2009.

Virginia–Status uncertain: *Eleocharis wolfii* is included on state's list of taxa whose status is uncertain (Virginia Department of Conservation and Recreation 2006). Available at http://www.dcr.virginia.gov/natural_heritage/documents/plantlist06.pdf. Accessed 7 Mar 2009.

Wisconsin–Endangered: Wolf's spikerush is included on the state's list of threatened and endangered species (Wisconsin Department of Natural Resources 2007). Available at: http://dnr.wi.gov/org/land/er/wlist/statelisted.asp?mode=detail&Grp=9. Accessed 7 Mar 2009.

ACKNOWLEDGMENTS

We are grateful to the numerous botanists, data managers, and species experts who provided information on *E. wolfii*: Jim Allison and Tom Patrick, GA NHP; Craig Anderson, WI DNR; Marlin Bowles, Morton Arboretum; Brent Baker, UARK Herbarium,; Charles Bryson, USDA; Amy Buthod, OK NHP; Bill Carr, TX Parks and Wildlife Department; Craig Freeman, McGregor Herbarium, University of Kansas (KANU); Rick Gardner, OH DNR; Fred Harris and Welby Smith, MN DNR; Bruce Hoagland, Oklahoma University; Tara Gibbs Kieninger, IL DNR; Karen Kreil USFWS; Barney Lipscomb, BRIT; Roger McCoy, TN Division of Natural Areas; Dave Moore, USFS; Leah Oliver, NatureServe; Justin Parks, ND NHP; John Pearson, Iowa DNR; David Rosen, Lee College, Baytown, TX; Al Schotz, AL NHP; Rick Schneider, NE Game and Parks Commission; Jason Singhurst, TX Parks and Wildlife; Tim Smith, MDC; Troy Weldy, NY NHP; and George Yatskievych, Missouri Botanical Garden (MO). S.G. Smith provided significant input on multiple portions of the manuscript. We thank John Pelton and George Yatskievych for providing photographs of culms, achenes and floral scales. Barney Lipscomb of BRIT helped clarify the status of the species in Texas. Robert Steinauer supplied us with detailed information on his survey results for the species in Nebraska. Charles Bryson of the USDA, Mike Penskar of the Michigan Natural Features Inventory and an anonymous reviewer provided helpful and constructive comments on an earlier draft of the manuscript. Elderine Milligan of the USFWS edited multiple drafts of the document.

REFERENCES

Alabama Department of Conservation and Natural Resources. 2006. County by county listing of Alabama species on the federal list for threatened and endangered species or whose status is a concern. Montgomery, Alabama. : http://www.outdooralabama.com/watchable-wildlife/regulations/endangeredbycounty.cfm; http://www.auburn.edu/herbarium/teplants.html. Accessed 7 Mar 2009.

Aldrich, J.R. and M.A. Homoya. 1984. Natural barrens and post oak flatwoods in Posey and Spencer counties, Indiana. Proc. Indiana Acad. Sci. 93:291–301.

Arkansas Vascular Flora Committee. 2006. Checklist of the vascular plants of Arkansas. Arkansas Vascular Flora Committee, University of Arkansas, Fayetteville.

Bowles, M.L., M.M. DeMauro, N. Pavlovic, and R.D. Hiebert. 1990. Effects of anthropogenic disturbances on endangered and threatened plants at the Indiana Dunes National Lakeshore. Nat. Areas J. 10:187–200.

Brummitt, R.K. and C.E. Powell. 1992. Authors of plant names. Royal Botanic Gardens. KEW.

Colorado Program. 1999. Colorado rare plant guide: master plant list. Colorado NHP. Fort Collins, Colorado. http://www.cnhp.colostate.edu/rareplants/masterlist.html#E. Accessed Mar 2009.

Dai, A., I.Y. Fung and A.D. Del Genio. 1996. Surface observed global land precipitation variations during 1900–1988. J. Climate 10:2943–2962.

Davit, C. (ed.) 1999. Public Prairies of Missouri. Third edition. Missouri Department of Conservation, Jefferson City.

Diggs, G.M. Jr., B.L. Lipscomb, M.D. Reed, and R.J. O'Kennon. 2006. Illustrated flora of east Texas. Volume one: introduction, pteridophytes, gymnosperms, and monocotyledons. Botanical Research Institute of Texas, Forth Worth.

Edwards, J.P., M. Cooley, and C.L. Godfrey. 1991. Soil survey of De Soto Parish, Louisiana. United States Department of Agriculture Soils Conservation Service, in cooperation with Louisiana Agricultural Experiment Station.

Eilers, L.J. and D.M. Roosa. 1994. The vascular plants of Iowa: an annotated checklist and natural history. University of Iowa Press, Iowa City.

Georgia Department of Natural Resources. 2008. Wildlife Resources Division. Special concern plant species in Georgia. Georgia DNR. Social Circle, Georgia. Accessed 7 Mar 2009.

Godfrey, R.K. and J.W. Wooten. 1979. Aquatic and wetland plants of the southeastern United States. Monocotyledons. University of Georgia Press, Athens.

González-Elizondo, M.S. and P.M. Peterson. 1997. A classification of and key to the supraspecific taxa in *Eleocharis* (Cyperaceae). Taxon 46:433–449.

Gray, A. 1874. Contributions to the botany of North America. 4. Characters of various new species. Proc. Amer. Acad. Arts 10:68–78.

Greenberg, J. 2002. A natural history of the Chicago region. University of Chicago Press, Chicago.

Hansen, J.E. 1989. The greenhouse effect: Impacts on current global temperature and regional precipitation. In: The challenge of global warming. Dean E. Abrahamson, ed. Island Press, Washington, D.C. Pp. 35–43.

Hedge, R.L., C.L. Hedge, M.A. Homoya, and C.Baker. 1994. Report on the status of *Eleocharis wolfii* in Indiana. Unpub. report. U.S. Fish and Wildlife Service, Project No: E1-7, Study No. 28.

Holm, L.G., J.V. Pancho, J.P. Herberger & D. L. Plucknett. 1979. A geographical atlas of world weeds. John Wiley & Sons, New York.

Illinois Endangered Species Protection Board. 2007. 2006 endangered and threatened species list. Springfield. Available at: http://www.dnr.state.il.us/espb/datelist.htm. Accessed Jan 2007.

Indiana Department of Natural Resources. 2007. Endangered, threatened, rare and extirpated plants of Indiana. Indianapolis. Available at: http://www.in.gov/dnr/naturepr/endanger/etrplants.pdf. Accessed Jan 2007.

Indiana Natural Heritage Data Center. 2009. Indiana DNR Division of Nature Preserves, Indianapolis.

Iowa Department of Natural Resources. 2007. Threatened and endangered species. DesMoines. Available at: http://www.iowadnr.com/other/files/chapter77.pdf. Accessed Jan 2009.

Kansas Department of Wildlife and Parks. 2005. Kansas Threatened and endangered species. Topeka. Available at: http://www.kdwp.state.ks.us/news/Other-Services/Threatened-and-Endangered-Species/Threatened-and-Endangered-Species. Accessed Mar 2009.

Keeney, D. and M. Muller. 2006. Water use by ethanol plants: potential challenges. Institute for Agriculture and Trade Policy, Minneapolis, MN.

Knue, J. 1997. Nebraskaland magazine wildlife viewing guide. Nebraskaland Mag. 75(1):1–96.

Kolstad, O.A.1986. Cyperaceae. In: Great Plains Flora Association, Flora of the Great Plains. University Press of Kansas, Lawrence.

Louisiana Department of Wildlife and Fisheries. 2009. Rare plants of Louisiana. Louisiana Department of Wildlife and Fisheries. Louisiana Natural Heritage Program. Baton Rouge. http://www.wlf.louisiana.gov/pdfs/experience/naturalheritage/rareplant/eleocharis%20wolfii.pdf. Accessed Mar 2009.

Martin, K. 1993. Status report on Wolf's spike-rush (*Eleocharis wolfii*), a candidate endangered species. Unpub. report. U.S. Fish and Wildlife Service, Bismarck, North Dakota.

Martin, C.E., L.J. Trahan, and C.T. Midkiff. 1981. Soil survey of Franklin Parish, Louisiana. United States Department of Agriculture Soils Conservation Service, in cooperation with Louisiana Agricultural Experiment Station.

Maschinski, J., J.E. Baggs, P.F. Quintana-Ascencio, and E.S. Menges. 2006. Using population viability analysis to predict the effects of climate change on the extinction risk of an endangered limestone endemic shrub, Arizona cliffrose. Conservation Biol. 20:218–228.

McKenzie, P.M. and B. Jacobs. 2000. New sites for two rare Missouri sedges: *Eleocharis wolfii* and *Fuirena simplex* var. *aristulata* (Cyperaceae). Missouriensis 21:31–38.

Michigan State University. 2007. Animal legal & historical web center. Statutes and lws. East Lansing, MI. Available at: http://www.animallaw.info/statutes/stusmi324_365.htm. Accessed Apr 2007.

Miles, C.C. 1988. Soil survey of Randolph County, Illinois. Soil Conservation Service.

Minnesota Department of Natural Resources. 2009. Rare species guide. Minnesota DNR, St. Paul, Minnesota. http://www.dnr.state.mn.us/rsg/a-z_search.html?action=a-zSearch&letter=E&column=SCIENTIFIC_NAME. Accessed Mar 2009.

Missouri Natural Heritage Program. 2009. Missouri species and communities of conservation concern checklist. Missouri Department of Conservation, Jefferson City.

Mohlenbrock, R.H. 1976. The illustrated flora of Illinois. Sedges-*Cyperus* to *Scleria*. Southern Illinois University Press, Carbondale.

Moody, K. 1989. Weeds reported in rice in south and southeast Asia. International Rice Research Institute, Manila, Philippines.

NatureServe. 2006. NatureServe Explorer: an online encyclopedia of life [web application]. Version 5.0. NatureServe, Arlington, VA. Available at: http://www.natureserve.org/explorer. Accessed Dec 2006.

NatureServe. 2009. NatureServe Explorer: an online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, VA. Available at: http://www.natureserve.org/explorer. Accessed Feb 2009.

Nebraska Game and Parks Commission. 2009a. The natural legacy project: a blueprint for conserving wildlife and their habitats. Lincoln. Available at: http://www.ngpc.state.ne.us/wildlife/programs/legacy/about.asp. Accessed Mar 2009.

Nebraska Game and Parks Commission. 2009b. The natural legacy project: a blueprint for conserving wildlife and their habitats. Chapter 3: Methodology: identifying ecological communities, at-risk species and biologically unique landscapes. Lincoln. Available at: http://www.ngpc.state.ne.us/wildlife/programs/grants/tier1.pdf. Accessed Mar 2009.

Nelson, P.W. 2005. The terrestrial natural communities of Missouri. Revised edition. The Missouri Natural Areas Committee, Jefferson City.

New York Natural Heritage Program. 2008. New York rare plant status lists. New York NHP, Albany. http://www.dec.ny.gov/docs/wildlife_pdf/nynhprpsl.pdf. Accessed Mar 2009.

Nowacki, G.L. and M.D. Abrams. 2008. The demise of fire and "mesophication" of forests in the eastern United States. BioScience 58:123–138.

Ohio Division of Natural Areas and Preserves. 2008. Rare native Ohio plants: 2008–09 status list. Ohio Department of Natural Resources, Columbus.

Oklahoma Natural Heritage Inventory. 2005. Rare and vulnerable plant species of Oklahoma. Oklahoma Biological Survey. Norman. Available at: (http://www.oknaturalheritage.ou.edu/plants_rare_vulnerable.htm) Accessed 7 Mar 2009.

Phillippe, L.R. 2005. Conservation assessment for *Eleocharis wolfii* (A. Gray) Patterson. Illinois Natural History Survey Center for Biodiversity Tech. Rep. 2005(7).

Robertson, K.R. and L.R. Phillippe. 1992. Report to the Illinois Endangered Species Protection Board on *Eleocharis wolfii* in Illinois. Illinois Natural History Survey unpub. rep., Champaign, Illinois.

Rolfsmeier, S.B. 1995. Keys and distributional maps for Nebraska Cyperaceae, Part 1: *Bulbostylis, Cyperus, Dulichium, Eleocharis, Eriophorum, Fimbristylis, Fuirena, Lipocarpha,* and *Scirpus*. Trans. Nebraska Acad. Sci. 22:27–42.

Rolfsmeier, S.B. and R. F. Steinauer. 1999. New floristic records for Nebraska-5. Trans. Nebraska Acad. Sci. 25:15–22.

Rosen, D.J. 2007. The vascular flora of Nash Prairie: a coastal prairie remnant in Brazoria County, Texas. J. Bot. Res. Inst. Texas 1:679–692.

Rosenzweig, C., A. Iglesias, X.B. Yang, P.R. Epstein and E. Chivian. 2000. Climate change and U.S. agriculture: the impacts of warming and extreme weather events on productivity, plant diseases and pests. Center for Health and the Global Environment, Harvard Medical School, Boston, MA.

Smith, S.G. 2001a. Taxonomic innovations in North American *Eleocharis* (Cyperaceae). Novon 11:241–257.

Smith, S.G. 2002. *Eleocharis* R. Brown subg. *Scirpdium* (Nees) Kukkonen. In: P.W. Ball, K. Gandhi, R.W. Kiger, D. Murray, J.L. Zarucchi, A.A. Reznicek, J.L. Strother, eds. Flora of North America North of Mexico, vol. 23 *Magnoliophyta: Commelinidae: Cyperaceae*. Oxford Univ. Press, New York. Pp. 107–112.

Smith, T. E. 2001b. Highlights of Missouri field botany. Missouriensis 22:16–21.

Steyermark, J.A. 1963. Flora of Missouri. Iowa State University Press, Ames [errata added at second printing, 1968].

Svenson, H.K. 1929. Monographic studies in the genus *Eleocharis*. I. Rhodora 31:121–135, 152–163, 167–191, 199–219, 224–242.

Svenson, H.K. 1932. Monographic studies in the genus *Eleocharis*. II. Rhodora 34:193–203, 215–227.

Svenson, H.K. 1934. Monographic studies in the genus *Eleocharis*. III. Rhodora 35:377–389.

Svenson, H.K. 1937. Monographic studies in the genus *Eleocharis*. IV. Rhodora 39:210–231, 236–273.

Svenson, H.K. 1939. Monographic studies in the genus *Eleocharis*. V. Rhodora 41:1–19, 43–47, 90–110.

Svenson, H.K. 1957. Cyperaceae. Tribe 2, Scirpeae. In: N.L. Britton et al., eds. 1905+. North American Flora….47+ vols. New York. Vol. 18. Pp. 505–556

Swink, F. and G. Wilhelm. 1979. Plants of the Chicago region: a checklist of the vascular flora of the Chicago region, with keys, notes on local distribution, ecology, and taxonomy, and a system for evaluation of plant communities, 3rd ed. Morton Arboretum, Lislie, IL.

Swink, F. and G. Wilhelm. 1994. Plants of the Chicago region: an annotated checklist of the vascular flora of the Chicago region, with keys, notes on local distribution, ecology, and taxonomy; a system for qualitative evaluation of plant communities, a natural divisions map, and a description of natural plant communities. 4th ed. Indiana Academy of Science, Indianapolis.

Taft, J.B., G.S. Wilhelm, D.M. Ladd, and L.A. Masters. 1997. Floristic quality assessment for vegetation in Illinois: a method for assessing vegetation integrity. Erigenia 15:3–95.

Tennessee Department of Environment and Conservation. 2008. Tennessee Natural Heritage Program: Rare Plant List-2008. Tennessee Department of Environment and Conservation. Division of Natural Areas. Nashville. Available at: (http://www.state.tn.us/environment/na/pdf/plant_list.pdf). Accessed 7 Mar 2009.

Texas Parks and Wildlife Department. 2004. A list of the rare plants of Texas. Texas Parks and Wildlife Department. Austin, TX. 21pp. Available at: (http://www.nature.org/wherewework/northamerica/states/texas/files/listofrareplants.pdf; http://www.tpwd.state.tx.us/huntwild/wild/species/endang/plants/index.phtml). Accessed 7 Mar 2009.

Thom, R.H. and J.H. Wilson. 1980. The natural divisions of Missouri. Trans. Missouri Acad. Sci. 14:9–23.

Thom, R.H. and J.H. Wilson. 1983. The natural divisions of Missouri. Nat. Areas J. 3(2):44–51.

Thomas, C.D., S.E. Williams, A. Cameron, R.E. Green, M. Bakkenes, L.J. Beaumont, Y.C. Collingham, B.F.N. Erasmus, M.F. deSiqueira, A. Grainger, L. Hannah, L. Hughes, B. Huntley, A.S. van Jaarsveld, G.F. Midgley, L. Miles, A. Ortega-Huerta, A.T. Peterson, and O.L. Phillips. 2004. Extinction risk from climate change. Lett. Nature 427:145–148.

Turner, L.M. 1934. Grassland in the floodplain of Illinois rivers. Amer. Midlland Naturalist 15:770–780.

U.S. Department of Agriculture. 2006. Regional forester sensitive plants. USDA, Milwaukee, WI.

U.S. Department of Agriculture. 2007. National Agricultural Statistics Service. Prospective plantings, Washington, D.C. Available at: http://www.nass.usda.gov/Newsroom/2007/03_30_2007.asp. Accessed Apr 2007.

U.S. Department of Agriculture-National Resources Conservation Service. 2009. The PLANTS Database. National Plant Data Center, Baton Rouge, Louisiana 70874-4490. USA. Available at (http://plants.usda.gov). Accessed May 2009.

U.S. Fish & Wildlife Service. 1993. Endangered and threatened wildlife and plants; review of plant taxa for listing as endangered or threatened species. Notice of review; 50 CFR Part 17. Fed. Reg. 58(188): 51444–51190. Sep 30.

Virginia Department of Conservation and Recreation. 2006. Natural heritage resources of Virginia: rare plants. Part three: review list (taxa of uncertain status). Virginia Department of Conservation and Recreation. Division of Natural Heritage, Richmond, VA. 61pp. Available at: (http://www.dcr.virginia.gov/natural_heritage/documents/plantlist06.pdf). Accessed 7 Mar 2009.

Vitousek, P.M. 1994. Beyond global warming: ecology and global change. Ecology 75:1861–1876.

Wilhelm, G.S. 1977. Ecological assessment of open land areas in Kane County, Illinois. Kane County Urban Development Division, Geneva, IL.

Wilhelm, G.S. 1978. Kane County natural area survey. Kane County Urban Development Division, Geneva, IL.

Wilhelm, G.S. and D. Ladd. 1988. Natural area assessment in the Chicago region. Trans. 53rd N. Amer. Wildlife & Nat. Resources Conf. 361–375.

Wilcove, D.S., D. Rothstein, J. Dubow, A. Phillips, and E. Losos. 1998. Quantifying threats to imperiled species in the United States. BioScience 48:607–615.

Wisconsin Department of Natural Resources. 2007. Wisconsin state threatened and endangered vascular plants. Wisconsin DNR, Madison, WI. Available at: (http://dnr.wi.gov/org/land/er/wlist/statelisted.asp?mode=detail&Grp=9). Accessed 7 Mar 2009.

Wisconsin Legislature. 2007a. Department of Natural Resources. Statute 29.604. Endangered and threatened species protected. Madison. Available at: http://nxt.legis.state.wi.us/nxt/gateway.dll?f=templates&fn=default.htm&vid=WI:Default&d=stats&jd=29.604. Accessed Apr 2007.

Wisconsin Legislature. 2007b. Department of Natural Resources. Statute NR 27 (03–07). Endangered and threatened species. Madison. Available at: http://www.legis.state.wi.us/rsb/code/nr/nr027.pdf. Accessed Apr 2007.

Yatskievych, G. 1999. Steyermark's flora of Missouri: volume 1- revised ed. Missouri Department of Conservation, Jefferson City.

Yatskievych, G. 2006. Steyermark's flora of Missouri: volume 2- revised ed. Missouri Botanical Garden Press in cooperation with the Missouri Department of Conservation, St. Louis.

Yatskievych, G. and J. Turner. 1990. Catalogue of the flora of Missouri. Monogr. Syst. Bot. Missouri Bot. Gard. 37. Braun-Brumfield, Inc., Ann Arbor, Michigan.

SALVINIA MINIMA AND *S. OBLONGIFOLIA* (SALVINIACEAE) NEW TO CALIFORNIA, WITH NOTES ON THE *S. AURICULATA* COMPLEX

Richard E. Riefner, Jr.
Research Associate
Rancho Santa Ana Botanic Garden
1500 North College Avenue
Claremont, California 91711-3157, U.S.A.
rriefner@earthlink.net

Alan R. Smith
Research Botanist
University Herbarium
University of California
1001 Valley Life Science Building #2465
Berkeley, California 94720-2465, U.S.A.
arsmith@berkeley.edu

ABSTRACT

Salvinia minima and *S. oblongifolia* are reported for the first time for California. These nonnative free-floating aquatic ferns likely escaped from residential or commercial ornamental ponds, water-gardens, aquaria or other cultivated sources. *Salvinia minima* is established in southern California, but *S. oblongifolia* is likely a non-persistent waif. We review the taxonomy of the "*Salvinia auriculata* complex" and re-examine previous determinations of sterile specimens using leaf venation characteristics in order to confirm the presence of *S. molesta* in California. We also provide a key to the identification of *Salvinia* species known or expected to occur in the State, and summarize the current naturalized status, habitats occupied, and regions where each species might become invasive.

Key Words: aquatic plants, *Salvinia minima*, *Salvinia molesta*, *Salvinia oblongifolia*, nonnative plants, wetlands, wildland-urban interface

RESUMEN

Salvinia minima y *S. oblongifolia* se reportan por primera vez en California. Estos helechos acuáticos de libre flotación no nativos posiblemente se dispersaron de estanques ornamentales, jardines acuáticos, acuarios o alguna otra fuente de cultivo. La *Salvinia minima* se estableció en el Sur de California pero la *S. oblongifolia* es posiblemente una planta abandonada no persistente. También revisamos la taxonomía del "complejo de *Salvinia auriculata*" y reexaminaremos las determinaciones previas de especimenes estériles utilizando las características de las venas de las hojas para confirmar la presencia de *S. molesta* en California. También proporcionaremos una clave para la identificación de las especies conocidas de *Salvinia*, así como de aquellas que se espera que se pudieran dar en el estado de California y resumiremos el estado actual de naturalización, los hábitats que ocupan y las regiones en las cuales cada especie se podría convertir en invasiva.

INTRODUCTION

Species of *Salvinia* are often difficult to identify, have a long history of use in cultivation, are known to escape and colonize indigenous wetlands, and often become invasive in new and remote regions around the world (Mitchell & Thomas 1972; de la Sota 1976; Forno 1983; Jacono & Pitman 2001). In this paper, we provide the first documented records of *Salvinia minima* Baker and *Salvinia oblongifolia* Mart. for California, and review their range, ecology, reproduction, potentially invasive behavior, mode of introduction, and likely pathways of dispersal.

Salvinia molesta D.S. Mitch. (giant salvinia or kariba-weed) has been reported previously for California (Hrusa et al. 2002; DiTomaso & Healy 2003; Riefner & Boyd 2005; Riefner & Boyd 2007). It is one of four morphologically similar species frequently referred to as the "*Salvinia auriculata* complex" (i.e., *S. auriculata* Aubl., *S. herzogii* de la Sota, *S. biloba* Raddi, and *S. molesta*), which are often difficult to separate when plants are infertile (Mitchell & Thomas 1972). To our knowledge, fertile *S. molesta* plants have not been documented growing outside of cultivation in California, making previous determinations problematic. We have determined and annotated sterile herbarium specimens of *S. molesta* by examining leaf primary venation patterns and comparing them with the illustrations depicted by Forno (1983). As a result, we confirm the presence of *S. molesta* in California, but cannot positively exclude other species in the *S. auriculata* complex. We also provide a key to the identification of *Salvinia* species known or expected to occur in the State, review the current naturalized status of urban and wildland habitats occupied by *Salvinia* species, and speculate on potential regions in California where each species might become invasive.

J. Bot. Res. Inst. Texas 3(2): 855 – 866. 2009

SALVINIA SPECIES NEW TO CALIFORNIA

Salvinia minima (water spangles, common salvinia) and *S. oblongifolia* (giant water velvet) have not been reported previously from California in treatments of the Salviniaceae that address nonnative species growing outside of cultivation (Hickman 1993; Nauman 1993; Bossard et al. 2000; Hrusa et al. 2002; DiTomaso & Healy 2003; Roberts et al. 2004; Rebman & Simpson 2006; Bossard & Randall 2007; Clarke et al. 2007; DiTomaso & Healy 2007; Riefner & Boyd 2007; Dean et al. 2008; Roberts 2008; Jepson Flora Project 2009; USDA 2009a).

Salvinia minima

Salvinia minima is a floating aquatic fern widely recognized as an invasive species in the southern United States (Madeira et al. 2003; ISSG 2006; USDA 2009a). Like many aquatic plants, the natural range of *S. minima* is difficult to determine because it is grown in greenhouses and botanical gardens, and used in the water-garden industry and the aquarium trade, where it frequently escapes cultivation (de la Sota 1976; Tryon & Tryon 1982). *Salvinia minima* is native to Florida and Georgia in the southeastern United States, southern and eastern Mexico, Bermuda, the Greater and Lesser Antilles, Central America, and South America from Venezuela to northern Argentina (Mickel & Smith 2004). Tryon & Tryon (1982) and DiTomaso & Healy (2003) also report *S. minima* as native to the southern United States or Florida. Others, however, believe it has been introduced to Florida and elsewhere in North America (Weatherby 1937; Crow & Hellquist 2000; Jacono et al. 2001; Morgan 2009). The potential native occurrence of water-lettuce (*Pistia stratiotes* L.) in Florida has also stimulated a similar debate (Schmitz et al. 1988).

In the United States, *S. minima* is now established outside of cultivation in Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, South Carolina, Texas, and Puerto Rico (Jacono et al. 2001; Jacono 2003; Morgan 2009). The USDA (2009a) maps these and other occurrences, including New Mexico and several mid-Atlantic and northeastern states. In New Mexico, *S. minima* is believed to be a non-persistent waif, and reports from Maryland, Massachusetts, New York, and Oklahoma have not been verified (Morgan 2009). A report from Minnesota also has not been confirmed (Nauman 1993).

Salvinia minima grows on still or stagnant waters of lakes and ponds, canals, slow-moving streams, ditches, shallow backwaters of bayous, oxbows, cypress swamps, marshes, and on mud (Lellinger 1985; Nauman 1993; Jacono et al. 2001). Much like *S. molesta*, the distribution of *S. minima* is, in part, limited by its low tolerance to freezing temperatures and saline waters (Jacono et al. 2001; Jacono 2003; Morgan 2009).

Salvinia minima is believed to be functionally sterile and like *S. molesta*, reproduces by continuous branching and fragmentation of rhizomes that generate large numbers of vegetative daughter plants (Schneller 1980; Jacono et al. 2001; Morgan 2009). Nauman (1993) recorded three apparently fertile specimens, all from Florida, and we have documented plants having a fertile axis growing in coastal San Diego County. Jacono (2003) reported that sporocarps are common on large plants in the southeastern United States.

Salvinia minima can reproduce at remarkably high rates and completely cover the surface of waterways if optimum growing conditions are present (Jacono et al. 2001; Jacono 2003; ISSG 2006). In the southern United States, particularly in Louisiana and Mississippi, *S. minima* is known to be a troublesome and invasive aquatic weed (Jacono et al. 2001). Dense infestations can block sunlight, decrease oxygen concentration to the detriment of other aquatic species, replace native plants that provide food and habitat for wildlife, clog irrigation systems, and block water intake screens and pipes of power plant facilities (Madeira et al. 2003; ISSG 2006). *Salvinia minima*, however, is prohibited only in Louisiana and Texas, and has not been included on the Federal Noxious Weed List or the State of California list of pest plants (Plant Protection & Quarantine 2002; California Department of Food & Agriculture 2008; Morgan 2009).

In southern California, *S. minima* is established at the wildland-urban interface (WUI) where it grows on mud, in algal mats, and shallow waters of urban drainages, and in stagnant backwaters of native wetlands. Because some plants in southern California are relatively small, likely owing to hydrological factors associated with urbanized watersheds (i.e., frequent flooding, fluctuations in water levels, and poor water quality), *S.*

minima could superficially resemble small patches of *Lemna* and therefore may be easily overlooked in the field (Fig. 1). Accordingly, *S. minima* may be more widespread in California than our records indicate.

Salvinia minima can overwinter in southern California stream environments or perennial wetlands when fragments of rhizomes are dispersed, get tangled in debris racks, and/or are sheltered among stems or roots of wetland plants, and then lie dormant until the return of favorable growing conditions in summer. Along Alberhill Creek, western Riverside County, *S. minima* grows in a large slough infested with *Eichhornia crassipes* (Mart.) Solms-Laubach (water hyacinth). In this population, discovered in February, 2009, most *Salvinia* plants show conspicuous symptoms of leaf dieback, and the pattern of browning is due presumably to cold-stress embolism. However, at this site *Salvinia* plants also produce new leaf growth and daughter plants at or just below the water surface, which apparently indicates its tolerance to cool winter temperatures. In the mild Mediterranean climate of Oceanside, in coastal San Diego County, the *S. minima* population discovered in April, 2009, overwinters without obvious cold-stress damage. At this site, and based on initial observations, *S. minima* can compete with but apparently cannot overgrow *Lemna* in stagnant waters of a culvert outflow basin (Fig. 2).

Accordingly, the ability of *Salvinia minima* to survive periods of reduced moisture or cool temperatures, and its potential for rapid vegetative reproduction have contributed to its ongoing invasive spread across the southern United States (Jacono 2003). *Salvinia minima* may not become a nuisance when growing in urban streams, but it could become invasive in sloughs, backwaters, ponds, and irrigation canals in California's mild Mediterranean coastal zones, possibly San Diego County, and the Lower Colorado River watershed in the Sonoran Desert region.

Salvinia minima is easily separated from other species of *Salvinia*, including species of the *S. auriculata* complex or *S. oblongifolia*, and other small floating aquatic plants using morphological features. *Salvinia minima* produces hairs on top of papillae that divide into four thin, spreading branches that remain free at the tips. *Salvinia minima* and *S. molesta* co-occur in drainages throughout the southeastern United States (Jacono 2003). In Brazil, *S. minima* can grow mixed with species of the *S. auriculata* complex (Forno 1983). Flooding, local environmental conditions, seasonal growth patterns, herbivory, and competition for space and nutrients with other floating plants may affect the local abundance of *S. minima* (Dickinson & Miller 1998). As a result, variable growth responses to environmental conditions and micro-habitat preferences in California could make detection of *S. minima* difficult in the field. In the Lower Colorado River, few *Salvinia* voucher specimens have been collected, and confusion between *S. minima* and small forms of *S. molesta* may be problematic (WAPMS News 1999). Therefore, small *Salvinia* plants growing with *S. molesta* populations or rafting with *Azolla* and *Lemna* should be examined carefully in order to avoid misidentifications.

As noted by Forno (1983) and Nauman (1993), botanists should make every effort to locate and collect fertile material to avoid misidentifications of sterile plants. In San Diego County, the fertile branches of *S. minima* plants bearing sporangia appear to be more-or-less subumbellate, i.e., originating at or near a common point on the axis, or divaricately branched (Fig. 3). However, the arrangement of the sporangia in the California specimens conflicts with the illustration of the fertile axis—elongate with the sporangia pinnately and alternately arranged—depicted by de la Sota and Jankowski (1996). The California material is somewhat similar to the fertile axis shown in the photograph of southeastern plants provided by Jacono (2003), but less elongate. Forno (1983) illustrated similar variation (short and long forms) of the fertile axes in *S. auriculata* and *S. herzogii*, and this may be an indication that minor variations of the fertile axis are not unusual in *Salvinia*. Accordingly, additional study and documentation is needed to accurately characterize the *S. minima* populations growing in California.

Specimens examined: **U.S.A. CALIFORNIA. Orange Co.:** City of Laguna Beach, vicinity of West St. and Pacific Coast Highway, UTM (NAD 83) 11S 0430540E 3707490N, elev. 4 m, growing in algae and shallow waters of a culvert outflow basin, 9 Jul 2008, *Riefner 08-219* (RSA, UC), same locality, 22 Oct 2008, *Riefner 08-307* (RSA). **Riverside Co.:** Cathedral City, Perez Rd. at Date Palm Dr., urban creek tributary to the Whitewater River, UTM (NAD 83) 11S 0550217E 3737981N, elev. ca. 82 m, uncommon but widely scattered, growing in algae, on mud, and in slow-moving waters, 5 Jul 2008, *Riefner 08-214* (RSA, UC); City of Lake Elsinore, S side of Alberhill Creek, W of Hwy. 74, along Baker St. vicinity of Bromley Ave. at Bennett St., UTM (NAD 83) 11S 0467394E 3728133N, elev. ca. 380 m, uncommon

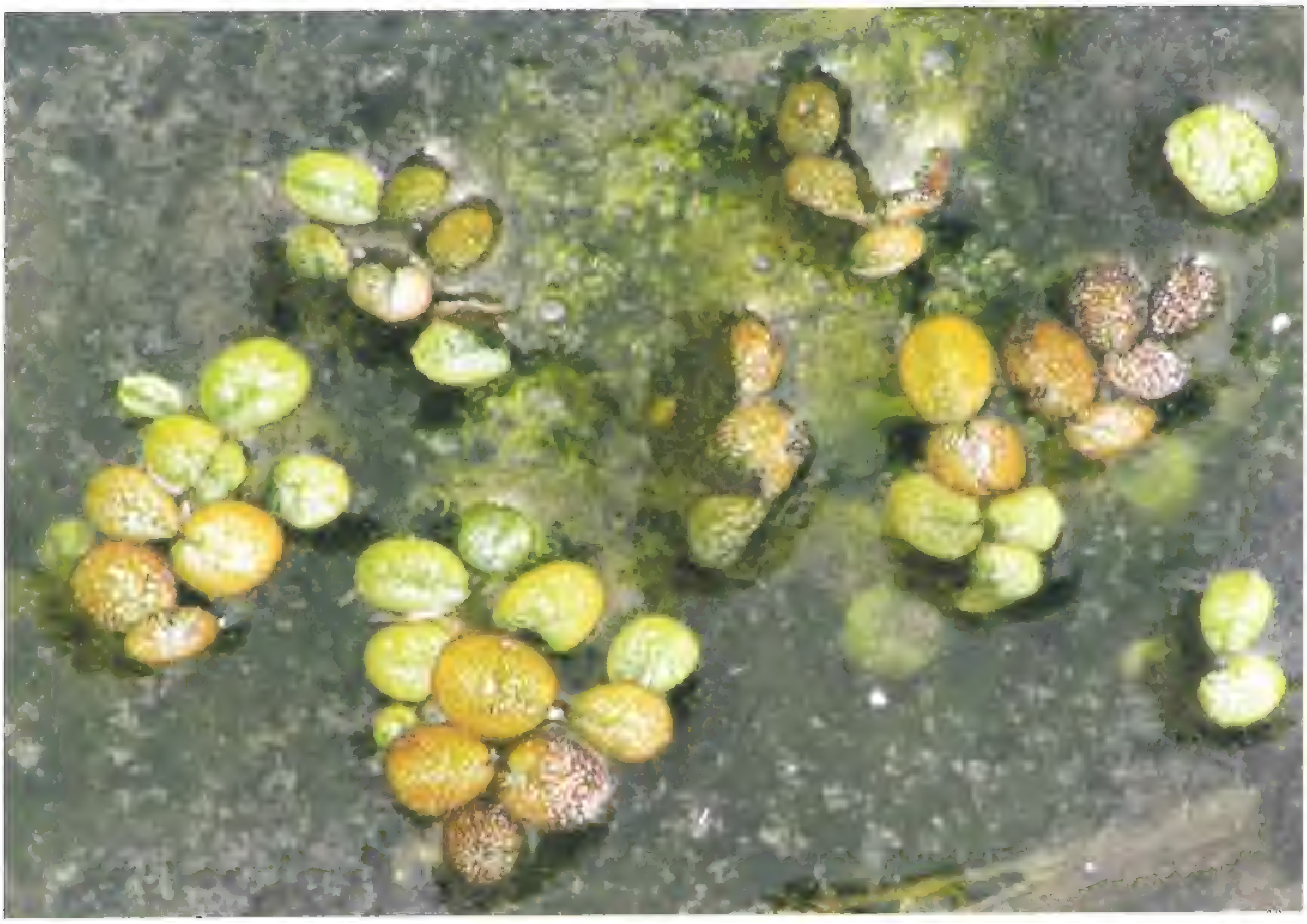


Fig. 1. ***Salvinia minima*** **plants in urban drainages may remain small owing to frequent flooding and poor water quality. These** ***Lemna*****-sized plants may easily be overlooked in the field when growing in algae and on mud. Photograph taken in July, 2008, at Cathedral City, Riverside County, California.**

but scattered in large slough infested with *Eichhornia crassipes*, 25 Feb 2009, *Riefner 09-17* (RSA, UC). **San Diego Co.:** City of Oceanside, North Santa Fe Ave. at Mesa Dr., UTM (NAD 83) 11S 0474261E 3678151N, elev. ca. 32 m, common but not invasive (fertile plants uncommon), growing with *Lemna* and *Wolffia* in culvert outflow basin, 9 Apr 2009, *Riefner 09-26* (RSA, UC).

Salvinia oblongifolia

Salvinia oblongifolia is native to Brazil where it can form dense, nearly pure colonies in lagoon habitats; occasionally, it can also grow mixed with species of the *S. auriculata* complex (de la Sota 1962; Richerson & Jacono 2005; Forno 1983). *Salvinia oblongifolia* is also grown for the horticultural industry, but is not known to grow in natural environments outside of cultivation in the United States (Kartesz & Meacham 2005; Richerson & Jacono 2005). Sexual reproduction is expected in *S. oblongifolia*, but it also reproduces primarily by vegetative propagation (Richerson & Jacono 2005).

Salvinia oblongifolia is a distinctive aquatic fern, and generally is easily identified (Fig. 4). *Salvinia oblongifolia* has somewhat rectangular floating leaves approximately three times as long as wide and short blunt papillae arranged in double rows on the upper leaf surface (Tryon & Tyron 1982; Richerson & Jacono 2005). Based on field observations, its prominent lower leaf keel and spongy aerenchyma tissue provide extra buoyancy and, like *S. molesta*, may increase its ability to compete for space on crowded waters by over-topping small floating plants and leaf debris.

In cultivation, *S. oblongifolia* is difficult to grow when temperatures drop below 50°F and its growth may also be impacted by fluctuations in pH (Jacono & Pitman 2001; Richerson & Jacono 2005). Accordingly, *S. oblongifolia* may not successfully overwinter in southern California. Although summer vegetative reproduction was observed in the Bixby Slough population, its presence may represent a non-persistent waif accidentally dispersed from cultivated sources to wildland habitats. *Salvinia oblongifolia*, however, could naturalize in

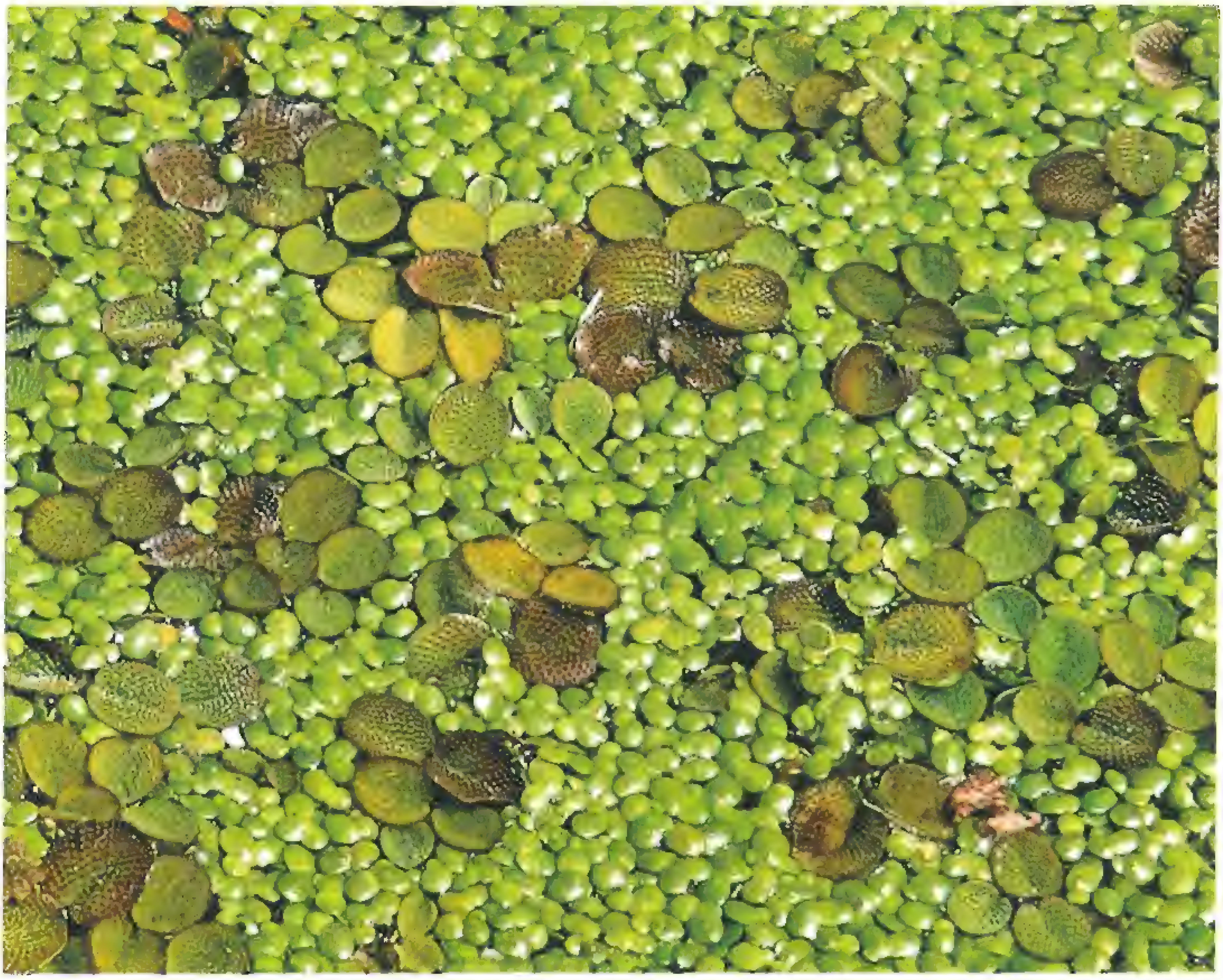


Fig. 2. *Salvinia minima* plants overwintering in a sheltered basin, coastal San Diego County. Some leaves are rusty brown, the coloration typically associated with maturity and senescence, but the plants do not exhibit symptoms of cold-stress embolism seen in a population discovered in the cooler, inland region of western Riverside County. Many of the older, larger *Salvinia* plants shown in this photograph are fertile. Photograph taken in April, 2009, City of Oceanside, San Diego County, California.

subtropical and tropical climate zones elsewhere in the southern United States, especially Florida (Jacono & Pitman 2001; Richerson & Jacono 2005).

Specimen examined: **U.S.A. CALIFORNIA. Los Angeles Co.:** Harbor City, Bixby Slough, vicinity of Dodge St. at 255th St., UTM (NAD 83) 11S 0380730E 3740064N, elev. ca. 11 m, uncommon, floating with *Lemna* sp. and *Ludwigia peploides* subsp. *montevidensis* in sluggish waters and clustered among emergent roots along bank of riparian woodland, 28 Jul 2008, *Riefner 08-251* (RSA, UC).

The Salvinia auriculata complex

Species of the *S. auriculata* complex share the defining character of "egg-beater" hairs (four hairs that join at the tip), which grow from the top of papillae on the upper surface of floating leaves (Mitchell & Thomas 1972). The floating leaves of all four species are orbicular to ovate, but vary widely in size according to environmental conditions and growth stage. Therefore, species of the *S. auriculata* complex are difficult to separate when fertile plants bearing sporocarps are absent (Tryon & Tryon 1982; Forno 1983; DiTomaso & Healy 2003; Mickel & Smith 2004).

Sporocarp-bearing plants are uncommon in the southern United States, and to our knowledge, fertile *S. molesta* has not been documented by herbarium specimens or reported in the literature for California (Hrusa et al. 2002; DiTomaso & Healy 2003; Riefner & Boyd 2005; Riefner & Boyd 2007). In Brazil, more than one species of the *S. auriculata* complex can grow together in the wild (Forno 1983). We cannot, therefore,

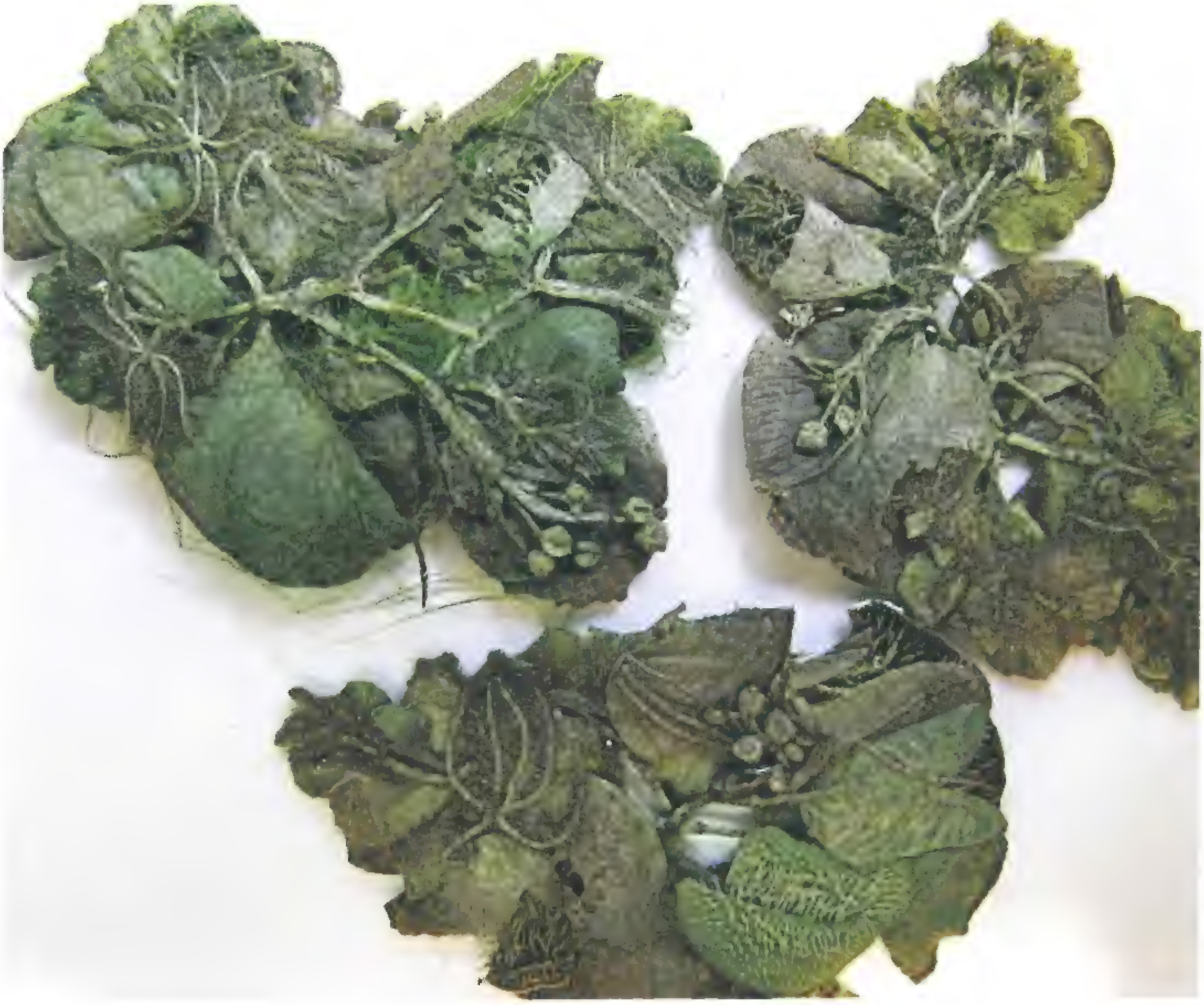


Fig. 3. Pressed and dried fertile *S. minima* plants collected from a culvert basin in Oceanside, San Diego County, showing sporangia born on a more-or-less subumbellate or a divaricately branched axis. The arrangement of the sporangia in the California specimens differs from the elongate, pinnately and alternately arranged sporangia illustrated by de la Sota and Jankowski (1996).

completely rule out the possibility that other species of the *S. auriculata* complex could occur in California. Accordingly, representative sterile herbarium specimens previously determined as *S. molesta* or identified as the *S. auriculata* complex representing a wide range of growth forms were selected for study using illustrations of leaf venation patterns and the methodology outlined by Forno (1983), which follows:

Methodology: Dried and pressed leaves were placed in boiling water with a few drops of household detergent for a few minutes and allowed to cool. The leaves were then scraped of surface hairs and cleared using a 5% NaOH solution (adapted here using 20% Clorox solution) to aid viewing the leaf venation patterns under a dissecting microscope. The venation pattern of each specimen was then compared to the species-specific illustrations depicted in Forno (1983). (Clearings made by A. Smith and H. Driscoll, with permanent slide mounts archived at UC.) Cleared leaves of specimens cited by CCH (2009) and deposited at CDA (Herbarium of California Department of Food and Agriculture) include: Imperial Co. (*Cason & Mizumoto s.n.*, *Herod & Pilman s.n.*), Mendocino Co. (*Harrie s.n.*), Riverside Co. (*O'Connell s.n.*), San Diego Co. (*Riveria s.n.*, *Stevens s.n.*), and San Luis Obispo Co. (*Knowles s.n.*, *Stoltz s.n.*).

As a result of this study, we confirm the presence of *S. molesta* in California, but cannot positively exclude *S. biloba*, which has somewhat similar venation. However, *S. auriculata*, which is morphologically similar to *S. molesta*, is the other species of the *S. auriculata* complex most likely to occur in southern California.

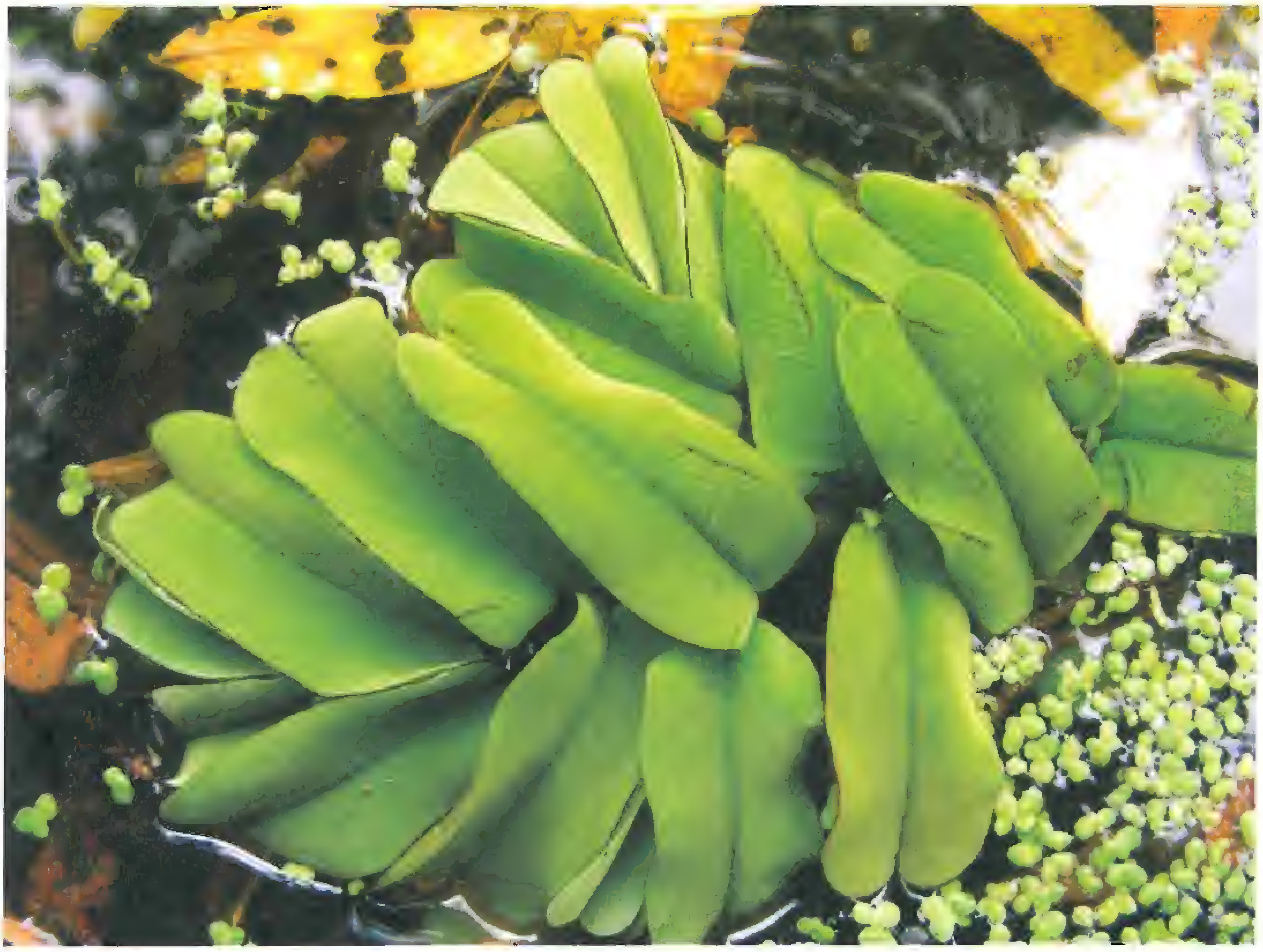


Fig. 4. ***Salvinia oblongifolia*** **has somewhat rectangular leaves approximately three times as long as wide and short blunt papillae that are arranged in double rows on the upper leaf surface, which make for easy identification. A prominent lower leaf keel and spongy aerenchyma tissue provide extra buoyancy that may increase its ability to overtop small floating plants, leaves, and roots, and compete for space on crowded surface waters. Photograph taken in July, 2008, at Bixby Slough, Harbor City, Los Angeles County, California.**

Salvinia molesta

Salvinia molesta is well known for its phenomenal growth rate and worldwide invasive spread, and is therefore widely regarded as one of the world's worst aquatic weeds (Holm et al. 1977; Thomas & Room 1986; Jacono & Pitman 2001). In the course of just a few decades, *S. molesta* spread from its native Brazil to aquatic habitats in many tropical and subtropical regions around the world, including the southern United States and northern Mexico (Jacono & Pitman 2001; McFarland et al. 2004; LCR 2009). It may be expected to co-occur wherever *Eichhornia crassipes* is established (McFarland et al. 2004), although *Salvinia* species appear to be more cold-sensitive.

Even the name of this *Salvinia* has been a source of contention. De la Sota (1995) replaced *S. molesta* with *S. adnata* Desv., an older name. However, because the Desvaux type is sterile and cannot be positively identified with confidence, and is also of uncertain provenance, the use of *S. adnata* should be considered a "name of uncertain application" (Moran & Smith 1999). Most authors have continued to use the name *S. molesta*, as recommended by Moran and Smith (1999).

In the United States, *S. molesta* was first documented in 1995 growing outside of cultivation in South Carolina; by 1999, the first collections from California were made from the Imperial National Wildlife Refuge, Imperial Co., from near Blythe, Riverside Co., in the Lower Colorado River drainage, from a pond near Fallbrook, San Diego Co., and from the San Diego River floodplain (without voucher), also in San Diego Co., southwestern California (Jacono & Pitman 2001; Hrusa et al. 2002). It has since been documented from canals near El Centro and Holtville in Imperial County, and from man-made ponds and native wetland habitats from coastal San Diego and Orange counties north to Fort Bragg, Mendocino County, in coastal northern California (CCH 2009). *Salvinia molesta* has been reported recently from Humboldt County, which is also in coastal northern California (Calflora 2009). Accordingly, the distribution of *S. molesta* in California is more widespread than previously mapped by McFarland et al. (2004) and Jacono & Richerson (2005).

Though benign within its native range, *S. molesta* is an aggressive aquatic menace that can suppress growth of native vegetation, degrade water quality and fish and wildlife habitats, clog irrigation canals, interfere with recreational activities and utilization of water resources, and impact numerous other wetland values and functions. *Salvinia molesta* and other species of the *S. auriculata* complex are included on the Federal Noxious Weed List, and therefore prohibited from importation to the United States and from transport across state lines (Plant Protection & Quarantine 2002). Although species of the *S. auriculata* complex are included on the State of California weed list ("A List") of pest plants, *S. molesta* has become an invasive pest in several national wildlife refuges located along the Lower Colorado River (California Department of Food & Agriculture 2008; LCR 2009). *Salvinia molesta* has also been identified as a "High Alert" plant by the California Invasive Plant Council (Bossard et al. 2006).

Salvinia molesta is distinguished from other species in the *S. auriculata* complex by the arrangement of the fertile axis, which bears a large number of sessile sporangia arranged in a dorsiventrally arranged cyme (Forno 1983). Sporocarps are small, ovoid, apiculate, and contain a high number of empty sporangia or abortive spores (Mitchell & Thomas 1972; Tyron & Tyron 1982). However, no fertile material of any *Salvinia* in California has been collected.

The leaf venation pattern of *S. molesta* was used by Forno (1983) to distinguish it from other members of the *S. auriculata* complex; however, this pattern is somewhat similar to that found in *S. biloba*. These two species can be carefully separated by examining the number and shape of the primary areoles situated between the keel and the margin of a tertiary leaf; i.e., 5 to 10 areoles in *S. molesta*, and 8 to 12 areoles in *S. biloba*, with the latter generally having 10 or more present. Because of the similarity of leaf size, shape, and patterns of venation, populations of *S. molesta* in California and Arizona should be carefully examined for the presence of fertile plants to ensure that *S. biloba* is not present in California. *Salvinia auriculata*, possibly to be expected in California, greatly resembles and can be confused with *S. molesta*. The leaf venation of *S. auriculata* is reticulate and similar to the venation of the outer third of a *S. biloba* leaf. Illustrations of the primary leaf venation patterns of *S. auriculata*, *S. biloba*, and *S. molesta*, and photographs of sporocarp-bearing plants are depicted in Forno (1983).

Salvinia auriculata has been reported previously from Mexico and Puerto Rico, but not from California (Mickel & Smith 2004; USDA 2009c). Therefore, *S. auriculata* is included in the following key that will serve to identify the sterile species of *Salvinia* known or expected to occur in California.

A KEY TO STERILE MATERIAL OF SPECIES OF *SALVINIA* IN CALIFORNIA (ADAPTED, IN PART, FROM FORNO 1983)

1. Floating leaf blades oblong, generally 2–3 times longer than wide; papillae (stalks) supporting hairs on upper blade surfaces < 0.1 mm long **S. oblongifolia**

1. Floating leaf blades round, or if slightly oblong (suborbicular), less than 1.5 times longer than wide; papillae supporting hairs on upper blade surfaces of well developed leaves to 1 mm long.

  2. Hairs on tips of papillae of upper surface of floating leaves free at tips; leaf blades generally 0.5—1.0 (–1.5) cm long **S. minima**

  2. Hairs on tips of papillae of upper surface of floating leaves joined into a darkened knot at tips ("egg-beater hairs"); leaf blades generally 1.5—2.5 cm long.

    3. Leaf venation of ± isodiametric or slightly elongate areoles (length to ca. 2 times width) in marginal 2/3 of leaf lobe; main axis of submerged leaves (root-like organs) with short, recurved branches distally; not known from CA, to be expected **S. auriculata**

    3. Leaf venation of areoles of unequal length (the outer much shorter than the inner) in marginal 2/3 of leaf lobe; main axis of submerged leaves (root-like organs) with distal branches not recurved; widespread in coastal and southern CA **S. molesta**

TABLE 1. Summary of distributional records, current naturalized status and occupied habitats, and potential invasive behavior of *Salvinia* species known or expected to occur in California.

Species	**Significance in California**	**Naturalized Status and Habitats**	**Potential Invasive Behavior**
Salvinia auriculata	Not currently known, but expected in southern counties	NCI	Possibly Sonoran Desert region
Salvinia minima	New to State; expected elsewhere in southern California	N – urban creeks NW – slough	Possibly coastal southern California, especially San Diego Co., and Sonoran Desert region
Salvinia molesta	Identification of infertile *S. molesta* confirmed. Similar species in the *S. auriculata* complex cannot be excluded	N – backyard ponds, agricultural ponds, drains, and canals NW – river channels, backwaters, and floodplain ponds	Sonoran Desert region, central and southern coastal regions, especially San Diego Co., but unlikely elsewhere
Salvinia oblongifolia	New to State; first record growing outside of cultivation in U.S.	C – slough	Unlikely in California

DISCUSSION

Urbanization in arid and semiarid regions often brings unintended changes to fluvial ecosystem processes and threats to native biodiversity, including replacement of ephemeral washes with year-round waters and the introduction of new exotic species (Schwartz et al. 2006; White & Greer 2006; Roach et al. 2008). Seasonal stream flows and summer-dry conditions of southern California's arid climate have in the past acted as a barrier to establishment by many nonnative plants dispersed at the WUI (Brigham 2007). The availability of year-round sources of water, however, generated by man-made activities has inadvertently created numerous new wetland and riparian habitats that have significantly increased the likelihood that nonnative facultative wetland plants escaping cultivation could migrate from benign urban environments outward along the WUI to establish in native wetland habitats (Riefner & Columbus 2008).

In addition to intentional introductions for water-gardens, federally listed noxious plants, including *S. molesta*, have also been inadvertently introduced as contaminants with non-invasive wetland plants sold over the internet (Kay & Hoyle 2001; Maki & Galotowitsch 2003). The continuing growth of internet sales and demand for the water-garden industry will increase the likelihood that species of *Salvinia* will continue to be introduced by cultivation and escape to California's urban and wildland wetland habitats.

As a result of field experiences in southern California and a review of pertinent literature, the new distributional records reported here, current urban and wildland habitats occupied by *Salvinia* species, and potential regions where *Salvinia* species might become invasive are summarized in Table 1. Naturalization categories shown in Table 1, which are somewhat subjective, follow Hrusa et al. (2002) in order to allow consistency in data compilation of new introductions, which include: naturalized in wildlands (NW); naturalized outside of wildlands, including WUI habitats (N); casual or waif populations (C); and no current information (NCI).

ACKNOWLEDGMENTS

We greatly appreciate the efforts of Harvey Brenneise and Irene Holiman (Library of Rancho Santa Ana Botanic Garden) for assistance with document retrieval, Fred Hrusa (California Department of Food and Agriculture, CDA) for a loan of specimens, and Heather Driscoll (UC Herbarium) for some slide preparations. Two anonymous reviewers provided helpful comments that greatly improved this manuscript. We also thank our friends and colleagues who provided locations and directions to ponds, basins, and sloughs that might support nonnative aquatic plants.

REFERENCES

Bossard, C.C. and J.M. Randall. 2007. Nonnative plants in California. In: M.G. Barbour, T. Keeler-Wolf, and A.A. Schoenherr, eds. Terrestrial vegetation of California, ed. 3. University of California Press, Berkeley. Pp. 107–123.

Bossard, C., M. Brooks, J. DiTomaso, J.M. Randall, C. Roye, J. Sigg, A. Stanton, and P. Warner. 2006. California Invasive Plant Inventory. California Invasive Plant Council, Publ. No. 2006-02, Berkeley.

Bossard, C.C., J.M. Randall, and M.C. Hoshovsky. 2000. Invasive plants of California's wildlands. University of California Press, Berkeley.

Brigham, C.A. 2007. Managing rare plants at the wildland urban interface: an example from the Santa Monica Mountains and Simi Hills. In: D.A. Knapp, ed. Flora and ecology of the Santa Monica Mountains. Southern California Botanists Special Publication, No. 4, Fullerton, CA. Pp. 109–130.

Calflora. 2009. *Salvinia molesta*. Available: http://www.calflora.org/cgi-bin/species_query.cgi?where-calrecnum=8734 [accessed March 2009].

California Department of Food and Agriculture. 2008. Plant quarantine manual, California plant quarantine policy – weeds. California Department of Food and Agriculture, Sacramento.

Clarke, O.F., D. Svehla, G. Ballmer, and A. Montalvo. 2007. Flora of the Santa Ana River and environs. Heyday Books, Berkeley.

Consortium of California Herbaria (CCH). 2009. SMASCH Accession Results: *Salvinia molesta*, *S. minima*, and *S. oblongifolia*. Available: http://ucjeps.berkeley.edu.edu/cgi-bin/get_chc.pl [accessed December 2008 – January 2009].

Crow, G.E. and C.B. Hellquist. 2000. Aquatic and wetland plants of northeastern North America: a revised and enlarged edition of Norman C. Fassett's A manual of aquatic plants, vol. 2, pteridophytes, gymnosperms, and angiosperms: dicotyledons. The University of Wisconsin Press, Madison.

Dean, E., F. Hrusa, G. Leppig, A. Sanders, and B. Ertter. 2008. Catalogue of nonnative vascular plants occurring spontaneously in California beyond those addressed in The Jepson manual–Part II. Madroño 55:93–112.

de la Sota, E.R. and L.S. Jankowski. 1996. Salviniaceae, Salviniáceas. In: H.B. Lahitte and J.A. Hurrell, eds. Plantas Hidrófilas de la Isla Martín García (Buenos Aires, República Argentina). Comisión de Investigaciones Cientificas, Buenos Aires. Pp. 28–29.

de la Sota, E.R. 1962. Contribución al conocimiento de las Salviniaceae Neotropicales I. *Salvinia oblongifolia* Martius II. *Salvinia auriculata* Aublet III. *Salvinia herzogii* nov. sp. Darwiniana 12:465–520.

de la Sota, E.R. 1976. Sinopsis de las especies Argentinas del genero *Salvinia* Adanson (Salviniaceae–Pteridophyta). Biol. Soc. Argent. Bot. 17:47–50.

de la Sota, E.R. 1995. Nuevos sinónimos en *Salvinia* Ség. (Salviniaceae–Pteridophyta). Darwiniana 33:309–313.

Dickinson, M.B. and T.E. Miller. 1998. Competition among small, free-floating, aquatic plants. Amer. Midl. Naturalist 140:55–67.

DiTomaso, J.M. and E.A. Healy. 2003. Aquatic and riparian weeds of the West. U.C. Agriculture and Natural Resources Publication 3421, Oakland, CA.

DiTomaso, J.M. and E.A. Healy. 2007. Weeds of California and other western states, vol. 2, Geraniaceae–Zygophyllaceae. U.C. Agriculture and Natural Resources Publication 3488, Oakland, CA.

Forno, I.W. 1983. Native distribution of the *Salvinia auriculata* complex and key to species identification. Aquatic Bot. 17:71–83.

Hickman, J.C. (ed.). 1993. The Jepson manual: higher plants of California. University of California Press, Berkeley.

Holm, L.G., D.L. Plucknett, J.V. Pancho, and J.P. Herberger. 1977. The world's worst weeds: distribution and biology. The University Press of Hawaii, Honolulu.

Hrusa, F., B. Ertter, A. Sanders, G. Leppig, and E. Dean. 2002. Catalogue of non-native vascular plants occurring spontaneously in California beyond those addressed in The Jepson manual–Part I. Madroño 46:61–98.

Invasive Species Specialist Group (ISSG) Database. 2006. Ecology of *Salvinia minima*. Available: http://www.issg.org/database/species/ecology.asp?si=570&fr=1&sts=&lang=EN [accessed January 2009].

Jacono, C.C., T.R. Davern, and T.D. Center. 2001. The adventive status of *Salvinia minima* and *S. molesta* in the southern United States and the related distribution of the weevil *Cyrtobagous salviniae*. Castanea 66:214–226.

Jacono, C.C and B. Pitman. 2001. *Salvinia molesta*: around the world in 70 years. Aquatic Nuisance Species Digest 4:13–16.

Jacono, C.C. and M.M. Richerson. 2005. Time series map – *Salvinia molesta*. Available: USGS http://salvinia.er.usgs.gov/html/distribution_map.html [accessed March 2009].

Jacono, C.C. 2003. *Salvinia minima* Baker. Available: USGS http://salvinia.er.usgs.gov/html/identification1.html [accessed December 2008 – April 2009].

Jepson Flora Project. 2009. Index to taxa recorded from California since The Jepson manual (range extensions from outside California and new naturalizations). Available: http://ucjeps.berkeley.edu/interchange/I_index_newrange.html [accessed December 2008-January 2009].

Kartesz, J.A. and C.A. Meacham. 2005. Synthesis of North American flora, version 2.0. North Carolina Botanical Garden, Chapel Hill.

Kay, S.H. and S. Hoyle. 2001. Mail order, the internet, and invasive aquatic weeds. J. Aquat. Pl. Managem. 39: 88–91.

Lellinger, D.B. 1985. A field manual of the ferns & fern-allies of the United States & Canada. Smithsonian Institution Press, Washington D.C.

Lower Colorado River Invasive Aquatic Species Working Group (LCR). 2009. Lower Colorado River giant *Salvinia* task force. Available: http://www.lcrsalvinia.org/salviniahome.asp [accessed January 2009].

Madeira, P.T., C.C. Jacono, P.W. Tipping, T.K. Van, and T.D. Center. 2003. A genetic survey of *Salvinia minima* in the southern United States. Aquatic Bot. 76:27–139.

Maki, K. and S. Galotowitsch. 2003. Mail-order sales of aquatic plants: a pathway for ANS introduction. ANS Update 9:1.

McFarland, D.G., L.S. Nelson, and M.J. Grodowitz. 2004. *Salvinia molesta* D.S. Mitchell (giant salvinia) in the United States: a review of species ecology and approaches to management. Aquatic Plant Control Research Program, ERDC/EL SR-04-2. U.S. Army Corps of Engineers Research and Development Center, Vicksburg, MS.

Mickel, J.T. and A.R. Smith. 2004. The pteridophytes of Mexico. Mem. New York Bot. Gard. 88:1–1055.

Mitchell, D.S. and P.A. Thomas. 1972. Ecology of water weeds in the Neotropics. UNESCO Technical Papers in Hydrology, No. 12.

Moran, R. and A.R. Smith. 1999. *Salvinia adnata* Desv. versus *S. molesta* D. S. Mitch. Amer. Fern J. 89:268–269.

Morgan, V.H. 2009. *Salvinia minima*. USGS: Nonindigenous Aquatic Species Database, Gainesville, FL. Available: http://nas.er.usgs.gov/queries/factsheet.asp?SpeciesID=297 [accessed January 2009].

Nauman, C.E. 1993. *Salvinia*. In: Flora of North America Editorial Committee, eds. Flora of North America north of Mexico, vol. 2, Pteridophytes and Gymnosperms. Oxford University Press, New York, NY. Pp. 336–338.

Plant Protection and Quarantine. 2002. Federal noxious weed list. USDA Animal and Plant Health Inspection Service, Washington D.C.

Rebman, J.P. and M.G. Simpson. 2006. Checklist of the vascular plants of San Diego County, ed. 4. San Diego Natural History Museum, San Diego, CA.

Richerson, M.M. and C.C. Jacono. 2005. *Salvinia*: *Salvinia oblongifolia*. Available: USGS http://salvinia.er.usgs.gov/html/salvinia_oblongifolia.html [accessed January 2009].

Riefner, R.E., Jr. and S. Boyd. 2005. Noteworthy collection: *Salvinia molesta*. Madroño 52:272–273.

Riefner, R.E., Jr. and S. Boyd. 2007. New records of wetland and riparian plants in southern California, with recommendations and additions to the National List of Plant Species that Occur in Wetlands. J. Bot. Res. Inst. Texas 1:709–730.

Riefner, R.E., Jr. and T. Columbus. 2008. *Paspalum vaginatum* (Poaceae), a new threat to wetland diversity in southern California. J. Bot. Res. Inst. Texas 2:743–759.

Roach, W.J., J.B. Heffernan, N.B. Grimm, J.R. Arrowsmith, C. Eisinger, and T. Rychener. 2008. Unintended consequences of urbanization for aquatic ecosystems: a case study from the Arizona Desert. BioScience 58:715–727.

Roberts, F.M., Jr. 2008. The vascular plants of Orange County, California: an annotated checklist. F.M. Roberts Publications, San Luis Rey, CA.

Roberts, F.M., Jr., S.D. White, A.C. Sanders, D.E. Bramlet, and S. Boyd. 2004. The vascular plants of western Riverside County, California: an annotated checklist. F.M. Roberts Publications, San Luis Rey, CA.

Schneller, J.J. 1980. Cytotaxonomic investigations of *Salvinia herzogii* de la Sota. Aquatic Bot. 9:279–283.

Schmitz, D.C., B.V. Nelson, L.E. Nall, and J.D. Schardt. 1988. Exotic aquatic plants in Florida: a historical perspective and a review of the present aquatic plant regulation program. Proceedings of the Symposium on Exotic Pest Plants, November 2–4, 1988, University of Miami, Miami, Florida. Technical Report NPS/NREVER/NRTR -91/06. Pp. 303–326.

Schwartz, M.W., J.W. Thorne, and J.H. Viers. 2006. Biotic homogenization of the California flora in urban and urbanizing regions. Biol. Conservation 127:282–291.

Thomas, P.A. and P.M. Room. 1986. Taxonomy and control of *Salvinia molesta*. Nature 320:581–584.

Tryon, R.M. and A.F. Tryon. 1982. Ferns and allied plants, with special reference to tropical America. Springer-Verlag, New York.

United States Department of Agriculture (USDA). 2009a. PLANTS database: plants profile for *Salvinia minima* Baker (water spangles). United States Department of Agriculture, Natural Resources Conservation District. Available: http://plants.usda.gov/java/profile?symbol=SAMI7 [accessed December 2008-January 2009].

United States Department of Agriculture (USDA). 2009b. PLANTS database: plants profile for *Salvinia molesta* Baker (kariba-weed). United States Department of Agriculture, Natural Resources Conservation District. Available: http://plants.usda.gov/java/profile?symbol=SAMO5 [January 2009].

United States Department of Agriculture (USDA). 2009c. PLANTS database: plants profile for *Salvinia auriculata* Aubl. (eared watermoss). United States Department of Agriculture, Natural Resources Conservation District. Available: http://plants.usda.gov/java/profile?symbol=SAAU [accessed February 2009].

WAPMS News. 1999. Giant salvinia found on the Lower Colorado River; meeting notes. Newsletter of the Western Aquatic Plant Management Society: Summer 1999.

Weatherby, C.A. 1937. A further note on *Salvinia*. Amer. Fern J. 27:98–102.

White, M.D. and K.A. Greer. 2006. The effects of watershed urbanization on the stream hydrology and riparian vegetation of Los Peñasquitos Creek, California. Landscape Urban Planning 74:125–138.

SAGINA CAESPITOSA (ALSINACEAE) IN COLORADO, U.S.A.

A.E. Porsild†
National Museum of Canada
Ottawa, Ontario, CANADA

W.A. Weber and R.C. Wittmann
University of Colorado Museum
UCB 265, Boulder, Colorado 80309, U.S.A.
bill.weber@colorado.edu

ABSTRACT

Sagina caespitosa (J. Vahl) Lange in H.J. Rink is reported for the first time in the United States from the Rocky Mountains of Colorado.

RESUMEN

Sagina caespitosa (J. Vahl) Lange in H.J. Rink se encuentra por la primera vez en Los Estados Unidos en los Montañas Rocosas de Colorado.

In this note, we report *Sagina caespitosa* (J. Vahl) Lange in H.J. Rink for Colorado and the United States. Otherwise, *S. caespitosa* occurs in North America in Greenland, Manitoba, Newfoundland, Labrador, Nunavut, and Quebec (Crow 2005).

According to the Flora of North America (Crow 2005), two species of *Sagina* occur in Colorado, namely *S. saginoides* and *S. procumbens*. For many years, we assumed that our only native species was the common *S. saginoides*. Erling Porsild visited in 1950 and the senior author took him, as he has Eilif Dahl, Eric Hultén and other European field botanists, on excursions to 14000-foot Mount Evans, the site of many significant alpine or arctic disjuncts (Weber 1965, 1991). Since then, the authors have repeatedly collected *Sagina* there and at similar sites. Recently, Wendy Dathan, Porsild's biographer (manuscript in preparation), sent me a copy of the page in his field notebook where he mentioned collecting *Sagina caespitosa* and how thrilled he was, since he had not seen it since Hudson Bay and Greenland. To Porsild should go the credit for the discovery.

Sagina caespitosa has been considered an Amphiatlantic species; however, in Colorado it is locally abundant on high mountain summits from 12000–13500 ft (3700–4100 m) altitude, on frost boils and well-developed gravelly moss tundra. Throughout the remainder of its range, *S. caespitosa* is not known to grow at elevations greater than 1500 ft (450 m).

A report of *S. nivalis* (Lindblom) Fries from Colorado by Rydberg (1906, p. 130) was overlooked until recently. Rydberg's report was erroneous, based on a Harry Patterson collection which is here assigned to *S. caespitosa*. *S. nivalis*, being a species of the American arctic, might also be expected in Colorado, but thus far it has not been detected; however, *S. nivalis* does occur in a few localities in Montana.

In the *Flora of North America* (Crow 2005), *Sagina saginoides* (L.) H. Karsten was described as "Plants perennial, tufted or *becoming caespitose in alpine habitats*." This is incorrect and all collections of *S. caespitosa* at Herbarium COLO were annotated as *S. saginoides*. In the field, *S.caespitosa* is easily distinguished by its tightly massed, button-like form. Plants are also characterized by short shoots lacking internodes, by stiffly erect pedicels, by plump, purplish sepals, and by petals equaling or slightly exceeding the calyx. It occurs on mature gravelly tundra usually at very high altitudes. The shoots can hardly be separated to make less bulky herbarium specimens.

Sagina nivalis (Lindblom) Fries might be expected to occur in Colorado, since it is a western American arctic species that reaches northern Montana. It differs from *S. caespitosa* by being 4-merous with petals shorter than the sepals, and by not being densely caespitose because of the lack of secondary shoots.

Sagina saginoides (L.) Fenzl is a very weak, often somewhat procumbent plant with obvious internodes, filiform pedicels and pale white sepals. Its habitat is not special, occurring on wet sand or mud, and it generally occurs at lower altitudes.

J. Bot. Res. Inst. Texas 3(2): 867 – 868. 2009

Voucher collections of *S. caespitosa*, Herbarium COLO: **COLORADO. Boulder Co.:** sandy seepage area between the two uppermost Green Lakes, T1N R754W Sec. 13, Green Lakes Valley N of Kiowa Peak, 11,500–12000 ft, Boulder watershed, 21 Jul 1953, *Weber & Dahl*; N slopes of Kiowa Peak Green Lakes Valley, 11,400–1200 ft, 1 Jul 1972, *Komarkova s.n.*; summit of South Arapahoe Peak on its southeast ridge, 13300 ft, 10 Jul 1972, *Komarkova s.n.* **Clear Creek Co.:** high mountains, vicinity of Gray's Peak, 23 Aug 1892 (as *S. nivalis*), *H.N. Patterson s.n.* [the collection cited by Rydberg (1906)] [on the specimen at F, an inked note says "halfway up"]; Summit Lake, Mount Evans, 12,800 ft, 5 Aug 1950, *Weber 5927*, 15 Aug 1950, *Weber, Porsild, & Holmen 5927, 11135, 22868*; 31 Jul 1954, *Weber & Dahl 8937*; 16 Aug 2006, *Weber 19505*; 16 Aug 2006, *Weber 19505;* 25 Aug 2007, *Weber & Wittmann 19514, 19515*; saddle between Mts. Evans and Epaulet, 13590 ft, 6 Aug 1998, *Weber & Wittmann 19403.* **El Paso Co.:** Pikes Peak, along auto highway, ca. 13,000 ft, 7 Aug 1932, *Penland, Wershing, & Hartwell 789* (COCO). **Larimer Co.:** Rocky Mt. Nat. Park. Trail Ridge, on terrace S of Iceberg Lake, 12000 ft, on bare wet humus around frost scars, 10 Jul 1961, *Willard 61131*; S flank of Sundance Mountain, on terrace with *Koenigia*, in wet humus of hummocks, 19 Jul 1960, *Willard 608*; N side of Hagues Peak, 13300 ft, in wet gravels of a very late snow accumulation area, 7 Aug 1961, *Willard 61185.* **Park Co.:** Mosquito Range, along stream N of Leavick Tarn, SSE of Peerless Mt. summit, 12320 ft, 30 Jul 1991, *Tonnessen & Roy 020;* Mosquito Pass, saturated area below snow-bed beside the jeep road, 30 Jul 2007, *Weber & Wittmann19527.*

ACKNOWLEDGMENTS

We thank Garrett Crow and Wendy Dathan for assistance. Del Wiens kindly reviewed the ms.

REFERENCES

Crow, G.E. 2005. *Sagina*. In: Flora of North America Editorial Committee, eds. Flora of North America North of Mexico. 5:140–147.

Dathan, P.W. 2010 estimated. The Reindeer Botanist: Alf Erling Porsild. Manuscript in preparation.

Weber, W.A. 1965. Mount Evans, concentration point for Pleistocene relict plants. Guidebook for one-day field conferences, Boulder Area, Colorado. International Association for Quaternary Research, VIIth Congress. Pp. 10–12.

Weber, W.A. 1991. The alpine flora of Summit Lake, Mount Evans, Colorado. 15(4):3–15.

ERIGERON BELLIOIDES (ASTERACEAE), NEW TO FLORIDA AND THE CONTINENTAL UNITED STATES

Randy L. Mears

10852 SW 88th Street, Unit #108
Miami, Florida 33176, U.S.A.

ABSTRACT

Through field work spanning a six-year period, *Erigeron bellioides* has been documented from several widely scattered localities in Miami-Dade County, Florida. A description, localities, associated species, and photographs are included.

RESUMEN

Mediante un trabajo de campo durante un periodo de seis años, *Erigeron bellioides* ha sido documentado de varias localidades diseminadas en el condado de Miami-Dade, Florida. Se incluyen una descripción, localidades, especies asociadasy, fotografías y una ilustración.

Erigeron bellioides DC. grows outside of cultivation in southern Florida (Fig. 1). The collections cited below are apparently the first records from Florida as well as the continental USA. The species was not included or mentioned in any of the following major floristic summaries: Correll and Johnston (1970), Cronquist (1980), Cronquist et al. (1994), Hickman (1993), Long and Lakela (1976), Wiggins (1980), Wunderlin and Hansen (2003), USDA-NRCS (2009).

Erigeron bellioides is native to the Greater Antilles in the southern Caribbean region (Wagner et al. 1999). It occurs on Cuba, Hispanola, and Puerto Rico (Loigier et al. 1982). It also occurs in the Bahama Archipelago (Correll & Correll 1996). The species has become established on some of the Hawaiian Islands as well as other Pacific islands (PIER 2009). I personally observed the species naturalized on the Hawaiian islands of Kauai and Oahu in May of 2004. *Erigeron bellioides* is referred to as "*bellorita*" in parts of its native range. Members of the genus often are referred to as "fleabanes."

Voucher specimens: **Florida. Miami-Dade Co.:** 10 May 2000, *Mears 4725* (DOV, FTG, USF); 11 Dec 2005, *Mears 4986* (DOV, FTG, USF); 4 Nov 2003, *Mears 4836* (DOV, FTG, USF); 20 Nov 2005, *Mears 4971* (DOV, FTG, USF); 11 Dec 2005, *Mears 4988* (DOV, FTG, USF); 2 Dec 2005, *Mears 4979* (DOV, FTG, USF).

The plants of *Erigeron bellioides* have been observed flowering throughout the year in south Florida and were growing on grassy roadsides and medians of parking areas, in damp to wet soil at all of the sites. The following species were associated: *Kyllinga brevifolia* Rottb., *Paspalum setaceum* Michx., *Eleusine indica* (L.) Gaertn., *Dichondra caroliniensis* Michx., *Pilea microphylla* (L.) Liebm., *Coronopus didymus* (L.) Sm., *Drymaria cordata* (L.) Willd. ex Schult., *Calyptocarpus vialis* Less., *Synadrella nodiflora* (L.) Gaertn., *Youngia japonica* (L.) DC., *Spermacoce verticillata* L., and *Oldenlandia corymbosa* L.

The following description of *Erigeron bellioides* is based on (Wagner et al. 1999; Correll & Correll 1996) and on personal observations made of the species as it occurs within Miami-Dade County. Plants with an oblique rootstock 1–3 cm long, sparingly and loosely villous throughout. Stems simple or few-branched, ascending or stoloniform, 4–10 cm long. Basal leaves rosulate, with a conspicuously margined petiole usually longer than the blade, blades suborbicular to broadly ovate, to ca. 3 cm long and wide, entire to obscurely few-toothed; cauline leaves few, much reduced, and mostly obovate to oblong. Heads solitary or 2–3; involucres 3–3.5 mm high, ca. 5 mm broad; phyllaries in ca. 2 series, linear, acute, strigillose. Rays white, barely as long as the phyllaries, tightly coiling at maturity. Achenes elliptic, flat, about 1 mm long, puberulent. Pappus brownish, about 1.5 mm long.

This species is distinctive among *Erigeron* species in the USA in its combination of annual duration, very small size, spatulate leaves arranged in a basal rosette, and much reduced cauline leaves.

J. Bot. Res. Inst. Texas 3(2): 869 – 871. 2009

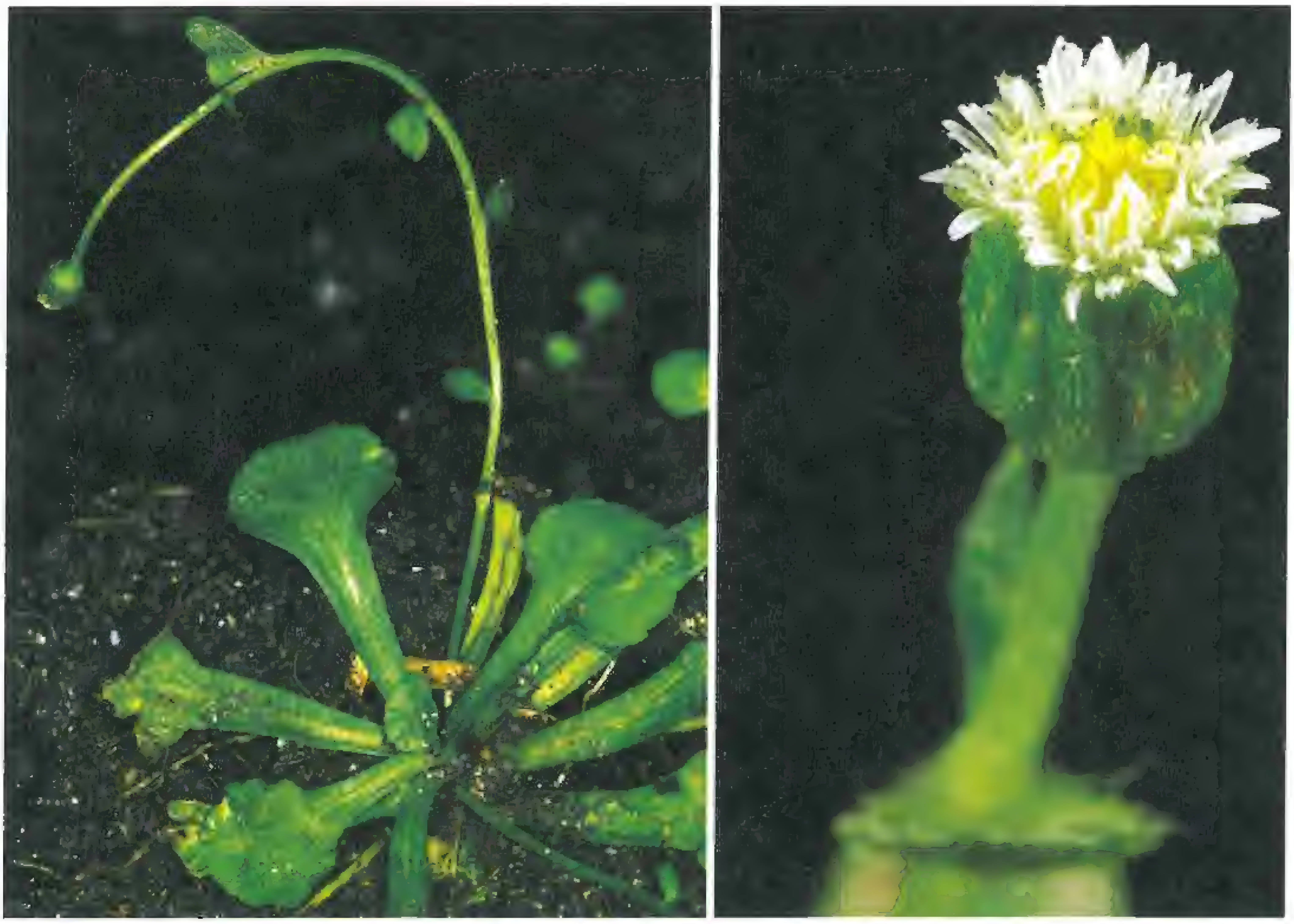


Fig. 1. Photographs of *Erigeron bellioides*, Miami-Dade County, Florida. Habit, *Mears 4725* (left); close up of flower (right, 19 Oct 2009). Photographs by Randy L. Mears.

ACKNOWLEDGMENTS

Guy L. Nesom provided helpful review comments that greatly improved an earlier version of this manuscript. I would also like to thank Robert F.C. Naczi of the New York Botanical Garden for so graciously critiquing and providing several helpful suggestions pertaining to the format and content of this paper.

REFERENCES

Correll, D.S. and M.C. Johnston. 1970. Manual of the vascular plants of Texas. The University of Texas Printing Division, Dallas, Texas.

Correll, D.S. and H.B. Correll. 1996. Flora of the Bahama Archipelago. A.R. Gantner Verlag KG., FL-9490 Vaduz.

Cronquist, A. 1980. Vascular flora of the southeastern United States Vol. 1, Asteraceae. Univ. of North Carolina Press, Chapel Hill.

Cronquist, A. et al. 1994. Intermountain flora: vascular plants of the Intermountain West, U.S.A. Volume 5 Asterales. New York Botanical Garden, Bronx.

Hickman J.C. 1993. The Jepson manual: higher plants of California. Univ. of California Press, Berkeley and Los Angeles.

Logier, H.A. and L.F. Martorell. 1982. Flora of Puerto Rico and adjacent islands: a systematic synopsis. Editorial Univ. Puerto Rico.

Long, R.W. and O. Lakela. 1976. A flora of tropical Florida: a manual of the seed plants and ferns of Southern Peninsular Florida. Banyan Books, Miami, Florida.

PIER. 2009. Pacific Island ecosystems at risk (PIER). Institute of Pacific Islands Forestry. <http://www.hear.org/pier/index.html>

USDA-NRCS. 2009. The PLANTS Database. National Plant Data Center, Baton Rouge, La. <http://plants.usda.gov>

WAGNER, W.L., D.R. HERBST, AND S.H. SOHMER. 1999. Manual of the flowering plants of Hawai'i revised edition Volume 1. Univ. of Hawai'i Press Bishop Museum Press, Honolulu.

WIGGINS, I.L. 1980. Flora of Baja California. Stanford Univ. Press, Stanford, California.

WUNDERLIN, R.P. AND B.F. HANSEN. 2003. Guide to the vascular plants of Florida, Second Edition. Univ. Press of Florida, Gainesville.

BOOK REVIEW

LYTTON JOHN MUSSELMAN, WITH FOREWARD BY GARRISON KEILLOR. 2007. **Figs, Dates, Laurel, and Myrrh: Plants of the Bible and the Quran.** (ISBN 978-0-88192-855-6, hbk.). Timber Press, Inc., 133 S.W. Second Avenue, Suite 450, Portland, Oregon 97204-3527, U.S.A. (**Orders:** www.timberpress.com, 1-800-327-5680, 1-503-227-3070 fax). $24.95, 336 pp., 255 color photos, 1 map, general index and index to verses in the Bible and Quran, 5 1/2" × 8".

From the publisher: "This book celebrates the plants of the Old Testament, New Testament, and Quran. From acacia, the wood of the tabernacle, to wormwood, whose bitter leaves, as absinthe, flavor alcoholic drinks, 81 chapters cover the more than 100 plants in the holy texts that have true botanical counterparts. Fascinating stories of the fruits, grains, grasses, trees, flowers, and fragrances include botanical characteristics, habitat, uses, and literary context. Richly illustrated with extensive color, this delightful ecumenical botany offers the welcome tonic of a deep look into an enduring, shared natural heritage."

Figs, Dates, Laurel and Myrrh: Plants of the Bible and the Quran is divided into sections that are based on each plant that was mentioned or alluded to in either the Bible or the Quran. The plants are listed alphabetically by their common names, but the author does list many of the scientific names through the various sections of this book. Each particular section differs slightly, but the reader will typically find a brief description of the plant (e.g. barley, onion, saffron, wheat) that includes color images and the plant's specific traits, habitat, and uses. Musselman also includes the actual scripture or simply the specific chapter or verse from the Bible or Quran as a reference for the reader.

It is interesting to note that the author does provide a list of the various Bible and Quran translations that were used in the production of this book. In some cases one plant is listed in only one of the religious sources (e.g. King James Version of the Bible versus the New Living Translation). From reading this book, it appears that Musselman truly understands the flora of this specific region in order to determine some of the particular plants that were mentioned within each text. This book was easy to understand and would be a good read for any person that is eager to learn more about the variety of plants that are listed in the Bible or the Quran.—*Keri McNew, MS Biology, Programs Manager, Botanical Research Institute of Texas, Fort Worth, Texas 76102-4025, U.S.A.*

About the author: "**Lytton John Musselman** has studied Bible plants in their native habitats for three decades and has published widely on their identification, symbolism, and use in the holy writings. He is Mary Payne Hogan Professor of Botany and chair of the Department of Biological Sciences at Old Dominion University in Norfolk, Virginia. He also wrote *Jordan in Bloom* (2000), which was commissioned by Queen Rania Al-Abdullah. With ongoing research projects in several countries, he is a frequent visitor to the Middle East, has held three Fulbright awards, and has served as a visiting professor at the American University of Beirut. Also a field naturalist, he co-edits *Haustorium*, a newsletter on parasitic plants, and is the manager of Old Dominion's Blackwater Ecological Preserve."

J. Bot. Res. Inst. Texas 3(2): 872. 2009

A FLORISTIC INVENTORY OF MARCO ISLAND (COLLIER COUNTY), FLORIDA

G.J. Wilder
Naples Botanical Garden
4820 Bayshore Drive
Naples, Florida 34112-7336, U.S.A.
GWilder@naplesgarden.org

B.J. Roche
Conservancy of Southwest Florida
1450 Merrihue Drive
Naples, Florida 34102-3449, U.S.A.
jeanr@conservancy.org

ABSTRACT

Marco Island, situated within the Gulf of Mexico and near the southern tip of peninsular Florida, exhibits six main kinds of natural habitats together with ruderal land and other disturbed areas. One hundred and eleven families, 324 genera, 461 species, and 470 infrageneric taxa (species, subspecies, varieties, and a hybrid) of vascular plants grow wild on the Island, and 325 of the infrageneric taxa are native to Florida. Individual native taxa inhabit from one to six of each of the six main kinds of natural habitats present. Fourteen of the infrageneric taxa are rare in Florida. *Trichostigma octandrum* is abundant on the Island, but might grow wild at solely two other localities in the United States.

Key Words: Flora, Marco Island, vascular plants

RESUMEN

Marco Island, situada en el Golfo de México y cerca del extremo sur peninsular de Florida, presenta seis tipos principales de hábitats naturales, junto con terrenos ruderales y otras áreas alteradas. En la isla crecen ciento once familias, 324 géneros, 461 especies, y 470 taxa infragenéricos (especies, subespecies, variedades, y un híbrido) de plantas vasculares, y 325 de los taxa infragenéricos son nativos de Florida. Los taxa nativos habitan en uno a seis de cada uno de los seis tipos principales de hábitats naturales presentes. Catorce de los taxa infragenéricos son raros en Florida. *Trichostigma octandrum* es abundante en la Isla, pero pudiera vivir únicamente en otras dos localidades en los Estados Unidos.

INTRODUCTION

This is the second paper of a series concerning the flora of southwestern Florida (Wilder & McCombs 2006). Herein, we present the results of a study of the native and nonnative taxa of vascular plants growing wild on Marco Island, Collier Co., Florida.

We undertook this study for five reasons. First, no published flora existed for Marco Island, overall. Second, the potential for additional residential development had created pressing need for a floristic inventory of the Island that would serve as a "baseline" for future floristic studies. Third, the Island flora appeared unusual compared to the floras of adjacent portions of mainland Florida, and included rare taxa. Fourth, we wished to document the flora by vouchering inventoried species. Previous investigators had produced species lists or accounts of species for parts of the Island, but had not cited herbarium specimens (Beriault 1980; Bradley 1999; James N. Burch [list reproduced in Collier County Facilities Management Department 2007]; Johnson and Muller 1993; Matt Finn and Eileen Ward [lists reproduced in Tsandoulas & Ward 2008]; Natural Areas Management Co., no date; Small 1924, 1929). In contrast, Gann et al. (2002) had cited specimens of rare taxa previously collected on the Island. Fifth, Marco Island, being subtropical, warranted study, because of the diversity and uniqueness of the Floridian subtropical flora.

We undertook a tripartite approach to this investigation. (**1**) We inventoried the wild native and nonnative taxa (Appendix I). (**2**) We intensively studied selected sites within the main kinds of natural habitats on Marco Island, in order to determine which native taxa occupied each kind of habitats and, for certain habitats, to gauge the frequency of these taxa (Appendix II). (**3**) We tabulated additional taxa of vascular plants collected by previous investigators on the Island but not encountered during the present study (Appendix I).

Marco Island has long appealed to floristic botanists. In addition to workers, aforementioned, the following noteworthy investigators made botanical visits to the Island: F. Almeda, George N. Avery, Leonard

J. Brass, Walter M. Buswell, Frank C. Craighead, Bruce Hansen, Olga Lakela, Robert W. Long, Harold N. Moldenke, Ruben P. Sauleda, Joseph H. Simpson, Daniel B. Ward, Richard P. Wunderlin, and Alvan W. Chapman (Chapman 1878; Wunderlin & Hansen 2008; Appendix I). John K. Small admired the Island flora at the Caxambas region (Austin 1987; Small 1922, 1923, 1929).

Geography, Climate, and Soils

Marco Island, centered at N 25°56'13.5" and W 81°42'57", is situated by the southern border of Collier County, in southwestern Florida. Encircled by the Gulf of Mexico, the Island is the largest of the Ten Thousand Islands group. Beriault (1980) cited measurements of 7.3 km along a north-south axis and 8.75 km along an east-west axis. Elevations range from sea level to 16 m (Beriault 1980).

Marco Island occurs within an area "...overlapped by a humid subtropical climate and a tropical savanna climate, in which temperatures are moderated by winds from the Gulf of Mexico and the Atlantic Ocean" (Collier County Facilities Management Department 2007). Yearly, there occur a well defined rainy season and dry season. Liudahl et al. (1998) reported seven soil types on Marco Island: urban land; urban land-Immokalee-Oldsmar, limestone substratum, complex; urban land-Aquents complex, organic substratum; udorthents, shaped; Durbin and Wulfert mucks, frequently flooded; Canaveral-Beaches complex; and, Paola fine sand, gently rolling. Wilder and McCombs (2006) reviewed the climate, geology, and soils of Collier County and of adjacent Lee Co.

Historical Sketch

Paleo Indians were the initial inhabitants of Florida, living there 12,000 years ago (Milanich 1994). Beriault (1980), summarizing previous literature, cited a pottery sherd from Marco Island that had been C-14 dated (by association with charcoal) as ca. 5150 years old.

In south Florida, The Calusa Indians succeeded the Paleo Indians. A nonagricultural people, the Calusa Indians hunted, fished, harvested mollusks, and gathered wild plant foods (Gilliland 1989, 1989a; Tebeau 1966). They modified Marco Island, creating canals, a sea wall, reservoirs, and three enormous shell mounds plus many smaller shell mounds. Mounds, composed largely of conch, oyster, and clam shells, were multi-functional, serving as refuse heaps and platforms. One mound, once located at the present site of Goodland on Marco Island, measured 1400 by 1700 feet (Beriault 1980; Tebeau 1965).

Marco Island ranks among the most important of archaeological sites in North America because of Indian artifacts. During 1895–1896 the archaeologist Frank Hamilton Cushing led the famous Pepper-Hearst Expedition to Key Marco (at the northwestern corner of Marco Island). From muck which Cushing interpreted as a courtyard, his team excavated superbly preserved Calusa remains: painted wooden masks, carved figurines, fishing nets, hafted tools, and many other objects (Gilliland 1989, 1989a).

Calusa Indians were in South Florida when Spaniards arrived during the early 1500s, but their civilization plummeted afterward because of warfare, disease, abduction by Europeans, and apparently migration. By 1800 almost all Calusa Indians were gone from the region (Tebeau 1966).

The William T. Collier family was the first permanent non-Indian settlers of Marco Island. Arriving in 1871, they encountered a few "squatters," but found the Island otherwise uninhabited (Perdichizzi 2006; Tebeau 1966). Additional pioneers followed, undertaking farming, construction, and other activities. Pioneers mined the shell mounds to build roads.

Three settlements arose on the Island: Key Marco (to the north; this is indicated as Marco Village, in Fig. 1), Caxambas (to the south), and Goodland (to the east). In 1926 the entire island was incorporated as Collier City (Tebeau 1966), but that municipality was discontinued. In 1998 the City of Marco Island was incorporated and now includes Key Marco, Caxambas, and additional land, but not Goodland (which remains an unincorporated portion of Collier County).

In 1922 Barron G. Collier (not related to W. T. Collier) purchased extensive property on Marco Island. Barron Collier died in 1939 and his descendants sold their Marco-Island holdings to the Deltona Corporation (Waitley 1999).

In 1964–1965 the Deltona Corporation initiated a revolutionary scheme for developing Marco Island,

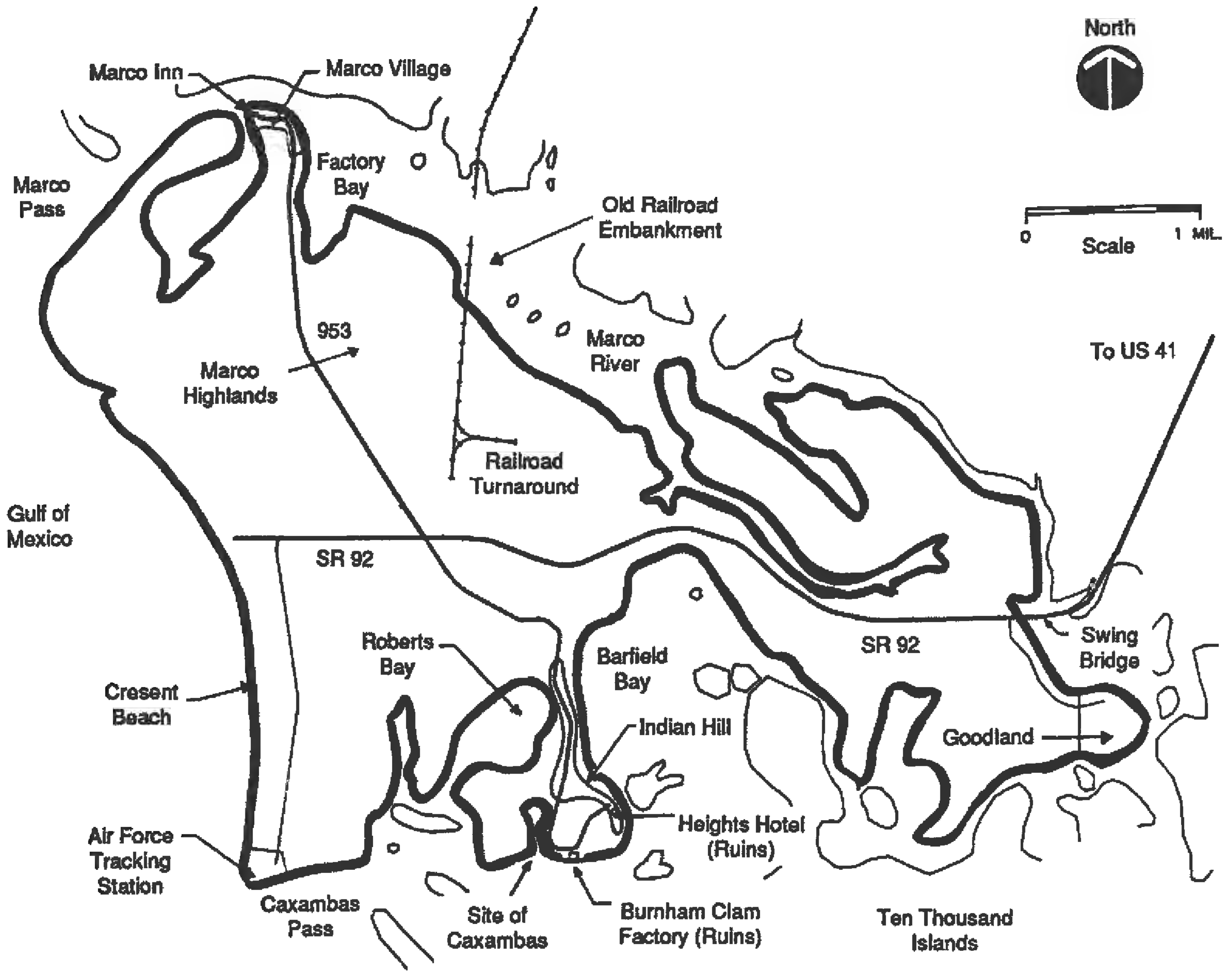

Marco Inn
Marco Village
Marco Pass
Factory Bay
Old Railroad Embankment
North
0
Scale
1 MIL.
953
Marco Highlands
Marco River
To US 41
Railroad Turnaround
Gulf of Mexico
SR 92
Roberts Bay
Barfield Bay
SR 92
Swing Bridge
Cresent Beach
Indian Hill
Goodland
Heights Hotel (Ruins)
Air Force Tracking Station
Caxambas Pass
Site of Caxambas
Burnham Clam Factory (Ruins)
Ten Thousand Islands

Fig. 1. Map of Marco Island as it appeared in 1962. A thick line demarcates the perimeter of the Island. Modified from Waitley (1999).

of a design and scope likely rivaled in few places elsewhere (cf. Figs. 1, 2). Catastrophic, from an ecological standpoint, the scheme included land clearing; road building; the construction of residential housing, of commercial buildings, of dikes, and of sea walls; dredging, filling, and the concomitant creation of an extensive matrix of many miles of canals (Waitley 1999). The acreage of the Island was increased from ca. 6,800 to 8,374 acres (Ms. Nancy Richie [City of Marco Island City Hall], personal communication of Dec. 8, 2008; Tebeau 1966). Construction obliterated natural areas, undoubtedly diminished taxonomic diversity, and probably rendered one species of plants extinct (*Lechea lakelae*). In the early 1980s, under pressure from government agencies and environmentalists, the Deltona Corporation ceased activities on the Island (Waitley 1999).

Seven main kinds of natural habitats occurred on Marco Island prior to development: mangrove swamps, saltwater marshes, freshwater marshes, pinelands (once covering much of the flat, sandy terrain in the center of the island), dense xeric scrub vegetation, tropical hammock, and unaltered shell mounds (Beriault 1980). Quoting from work of J. Miller and M. Fryman, of 1978, Beriault (1980) also indicated "a dynamic sand beach, shore and lagoon strand."

METHODS

One hundred and eleven field trips were conducted at Marco Island from 2003–2009, with most visits in 2008. The majority of field work was undertaken during the rainy season (lasting from June through September or October) and early and late in the dry season.

We investigated widespread portions of Marco Island, including publicly owned and privately owned areas. Private properties especially valuable to this study were Hideaway Beach Golf Club and the Key Marco development, each manifesting certain taxa absent elsewhere on the Island.

Except for noting *Sonchus oleraceus*, a European weed broadly dispersed within the United States, we did not inventory plant species at Otter Mound Preserve, a disturbed 2.46 acre shell mound and recently-established Collier County park situated southward on the Island. A home site in the early 1900s, this property was planted repeatedly with native and nonnative species and planting continues today. Repeated

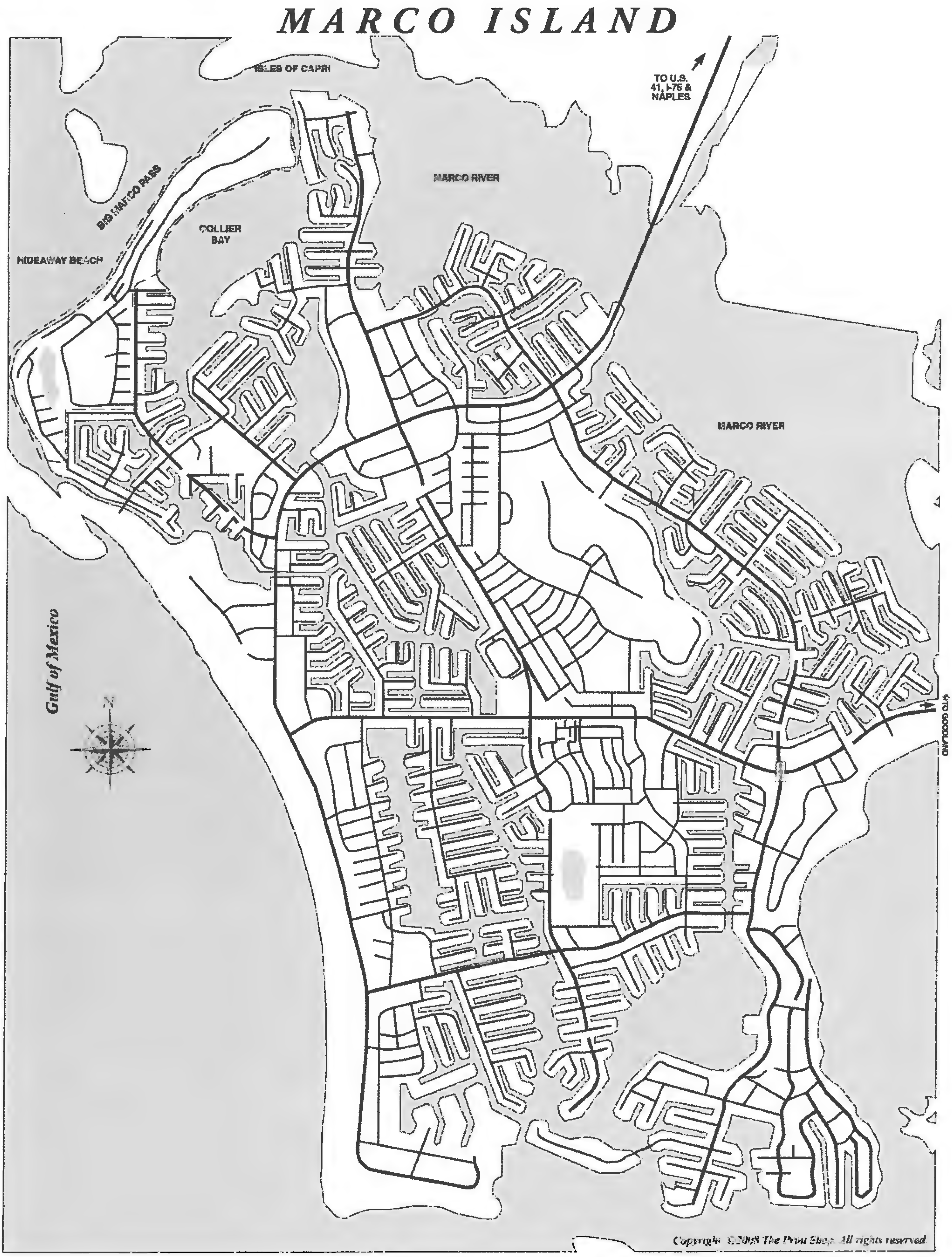

MARCO ISLAND
ISLES OF CAPRI
TO U.S. 41, I-75 & NAPLES
MARCO RIVER
BIG MARCO PASS
COLLIER BAY
HIDEAWAY BEACH
MARCO RIVER
Gulf of Mexico
N
TO GOODLAND
Copyright ©2008 The Print Shop. All rights reserved.

Fig. 2. Map of the western portion of Marco Island, as this portion appears today. Note the increased number of streets and the matrix of numerous canals contiguous with the Gulf of Mexico.

plantings have made it questionable which plants grow there naturally, thus making this area untenable for the present study. James N. Burch—botanist of the Big Cypress National Preserve—had inventoried plants of Otter Mound Preserve during 2007, recording 127 plant species (Collier County Facilities Management Department 2007). Burch listed certain species excluded from our own inventory of Marco Island.

In addition to compiling an island-wide inventory, we determined which native taxa occupied each of the main kinds of natural habitats remaining on the Island (Appendix 2). We did so, by surveying, repeatedly, selected sites of each kind of habitats (Table 1). For coastal tropical hardwood hammock and scrubland we surveyed sites that were fairly uniform in size—each site ca. the size of a housing lot (the sole exception being a larger hammock; Table 1, hammock no. 3). For these two kinds of habitats, the comparable sizes of sites studied enabled us to compare, quantitatively, the frequencies of individual taxa present within each kind of habitats. We surveyed coastal strand vegetation within large areas of Crescent Beach, Hideaway Beach, Sand Dollar Island (a sand spit protruding into the Gulf of Mexico), and Tiger Tail Beach. We surveyed mangrove habitat along the eastern and western sides of the Island. Pine flatwoods was represented by a parcel of second growth, described below.

We documented taxa with dried herbarium specimens (Appendix 1). Specimens have been deposited at the Herbarium of Southwestern Florida (SWF), housed at the Naples Botanical Garden.

We also compiled a list of taxa that previous workers had collected on Marco Island, but that we did not observe there (Appendix 1), based on sources cited in that Appendix. The list is probably incomplete because the sources are still being developed (Virtual Herbarium 2008; New York Botanical Garden 2008; Wunderlin & Hansen 2008).

We characterize taxa as native, alien, and endemic to Florida, according to Wunderlin and Hansen (2003). Mostly, our nomenclature for species and infraspecific taxa follows Wunderlin and Hansen (2003); however, Appendix 1 (footnote 1) specifies nomenclatural differences between that work and the present paper.

Brenda Thomas (of Florida Gulf Coast University [FGCU]) provided GPS readings, using a Garmin 60 CSx GPS unit. Brian Bovard (of FGCU) measured the salinity of a water sample from Marco Lake, using an MR100ATC refractometer at room temperature (Milwaukee Instruments, Rocky Mount, NC). Dr. Bovard undertook two measurements: the first with microorganisms in place, the second with microorganisms removed by centrifugation (3,700 rpm for 10 minutes).

RESULTS AND DISCUSSION

Natural Habitats Remaining on Marco Island

Mangrove forest and coastal strand vegetation are the most abundant kinds of remaining natural habitats. Mangrove forest grows intermittently along/near the shoreline and lagoons. Coastal strand vegetation exists primarily by the western shore of the Island: at Crescent Beach, Tiger Tail Beach County Park, Sand Dollar Island, and Hideaway Beach Golf Club.

Previous workers classified coastal strand vegetation in different ways (Johnson & Barbour 1990). For Marco Island, for purposes of simplicity we define two well-delimited zones of beach habitat, collectively, as coastal strand vegetation: an herbaceous zone and a woody-plant zone. Generally, the herbaceous zone is seaward of the woody-plant zone, and the two zones typically border and interdigitate with one another. Based on terminology of the Florida Natural Areas Inventory (1990), the herbaceous zone includes "beach dune" and "coastal grassland," whereas the woody-plant zone corresponds to "coastal strand." The herbaceous zone exhibits primarily herbaceous species, but also includes low-growing woody species and sporadic seedlings, saplings, and stunted individuals of woody species that normally grow larger in other habitats (e.g., species of mangroves). In the woody-plant zone, shrubs and trees are most conspicuous.

Coastal tropical hardwood hammock and scrubland are rare. Hammock remnants survive medially on the Island and westward at Hideaway Beach Golf Club. Scrubland remnants persist more-or-less medially also.

Eliminated totally from Marco Island are saltwater marshes, freshwater marshes, unaltered shell mounds,

Table 1. List of certain of the localities cited in this paper. Indicated, sequentially for each locality are GPS coordinates, the potential error of these coordinates, the street bordering the locality, and the side of that street nearest the locality (listed between parentheses). For localities exhibiting *Trichostigma octandrum* habitats are also listed. **E** = east; **N** = north; **S** = south; **W** = west.

SELECTED REMNANTS OF COASTAL TROPICAL HARDWOOD HAMMOCK

1. N 25° 56.198', W 81° 40.936', ± 18 ft; Sheffield Ave. (N)
2. N 25° 56.227', W 81° 41.359', ± 16 ft; Sheffield Ave. (S)
3. N 25° 56.303', W 81°41.138', ± 16 ft; San Marco Dr. (N)
4. N 25° 56.133', W 81° 41.616', ± 20 ft; Sheffield Ave. (S)
5. N 25° 56.228', W 81° 41.156', ± 20 ft; Sheffield Ave. (S)
6. N 25° 55.804', W 81° 40.636', ± 16 ft; Whiskey Creek Dr. (W)
7. N 25° 57.766', W 81° 44.545', ± 17 ft; Royal Marco Way (E)

SELECTED REMNANT OF PINE FLATWOODS

N 25° 57.089', W 81° 43.428', ± 19 ft - Bald Eagle Dr. (W)

SELECTED REMNANTS OF SCRUBLAND

1. N 25° 55.048', W 81° 42.012', ± 14 ft; S. Barfield Dr. (E)
2. N 25° 56.282', W 81° 41.299', ± 14 ft; San Marco Dr. (S)
3. N 25° 56.253', W 81°41.407', ± 13 ft; Sheffield Dr. (N)
4. N 25° 54.899', W 81° 41.735', ± 14 ft; Caxambas Dr. (E)
5. N 25° 55.016', W 81° 41.949', ± 14 ft; Inlet Dr. (W)
6. N 25° 56.819', W 81° 43.212', ± 15ft; Bald Eagle Dr. (E)

LOCATIONS OF WILD POPULATIONS OF *TRICHOSTIGMA OCTANDRUM*

1. N 25° 54.753', W 81° 41.933'; ± 16 ft; Addison Ct. (N); a field containing tree islands; 8 of these islands exhibit *Trichostigma*
2. N 25° 55.044', W 81° 42.001', ± 15 ft; S. Barfield Dr. (E); by disturbed scrubland
3. N 25° 54.943', W 81° 41.776'; ± 11 ft; Caxambas Dr. (E); disturbed land situated behind scrubland
4. N 25° 54.927', W 81° 41.720'; ± 19 ft; Caxambas Dr. (E); disturbed land
5. N 25° 54.780', W 81° 41.586'; ± 19 ft; Caxambas Dr. (E); peripheral portion of forest
6. N 25° 54.651', W 81° 41.636'; ± 18 ft; Caxambas Dr. (N of the 180° turn); abundant on trees along a large field
7. N 25° 55.373', W 81° 41.891'; ± 16 ft; Inlet Dr. (E); disturbed land
8. N 25° 54.682', W 81° 41.830'; ± 13 ft; Inlet Dr. (E); tree island within field
9. N 25° 55.169', W 81° 41.945'; ± 16 ft; Inlet Dr. (W); disturbed land
10. N 25° 54.913', W 81° 42.147'; ± 17 ft; Ludlow Rd. (N); disturbed land
11. N 25° 54.947', W 81° 42.274'; ± 17 ft; Ludlow Rd. (N); disturbed scrubland
12. N 25° 54.786', W 81° 41.734'; ± 17 ft; Scott Dr. (E); disturbed land
13. N 25° 56.133', W 81° 41.620', ± 23 ft; Sheffield Ave. (S); coastal tropical hardwood hammock
14. N 25° 56.203', W 81° 41.503', ± 22 ft; Sheffield Ave. (S); coastal tropical hardwood hammock
15. N 25° 56.103', W 81° 41.693', ± 22 ft; Sheffield Ave. (S); coastal tropical hardwood hammock

and original pine flatwoods. A small parcel of flatwoods exists, as do a few highly disturbed pineland fragments, but the flatwoods is misleading. The parcel was stripped of vegetation and used as a borrow pit. Vegetation reappeared naturally, as second growth. In 1984, following re-growth of the vegetation, the parcel was dedicated as a nature park, but the park was abandoned (Natural Areas Management Co., no date; The Marco Island Eagle 1984).

A few artificial ponds exist. At least one pond (Marco Lake) exhibits fresh water (Brian Bovard; salinity measurement of Dec. 4, 2008). We noted species at the periphery of Marco Lake that we did not observe elsewhere on the Island (e.g., *Eleocharis interstincta*, *Ipomoea sagittata*, *Lygodium microphyllum*, *Melaleuca quinquenervia*, and *Thelypteris interrupta*).

Taxonomic Analysis of Present Data

The flora of Marco Island includes 111 families, 324 genera, 461 species, and 470 infrageneric taxa (species, varieties, subspecies, and a hybrid; appendix I). Between parentheses, the numbers of families, genera, and infrageneric taxa are indicated, respectively, for each of the following major groups of vascular plants:

pteridophytes (10, 13, 19), gymnosperms (1, 1, 1), angiosperms (100, 310, 450), monocotyledons (17, 67, 134), and dicotyledons (83, 243, 316). For infrageneric taxa of each of these major groups, their percentage of all 470 infrageneric taxa is listed: pteridophytes, 4.0%; gymnosperms, 0.2%; angiosperms, 95.7%; monocotyledons, 28.5%; and dicotyledons, 67.2%.

The eight largest families of monocotyledons on Marco Island, as gauged by the numbers of infrageneric taxa present, are Poaceae (64), Cyperaceae (34), Bromeliaceae (8), Agavaceae (4), Commelinaceae (4), Amaryllidaceae (3), Arecaceae (3), and Orchidaceae (3) (for each family, the number of infrageneric taxa is listed between parentheses). The families Poaceae and Cyperaceae, collectively, exhibited 20.9% of all 470 infrageneric taxa listed (i.e., 98 infrageneric taxa).

The eight largest families of dicotyledons on the Island, as gauged by the numbers of infrageneric taxa present, are Fabaceae (43), Asteraceae (42), Euphorbiaceae (22), Rubiaceae (17), Amaranthaceae (8), Malvaceae (8), Myrtaceae (8), and Convolvulaceae (7). The families Fabaceae and Asteraceae, collectively, exhibited 18.1% of all 470 infrageneric taxa listed (i.e., 83 infrageneric taxa).

Native and Endemic Taxa Inventoried During the Present Study

Sixty nine and eight tenths percent of all 470 infrageneric taxa are native to Florida (i.e., 328 taxa; Wunderlin and Hansen 2003). The percentage of native infrageneric taxa within each major group of vascular plants is listed: pteridophytes (73.7%), gymnosperms (100%), angiosperms (69.6%), monocotyledons (68.7%), and dicotyledons (69.9%).

Ten infrageneric taxa presently inventoried are endemic to Florida (Wunderlin and Hansen 2003): *Agave decipiens*, *Asimina reticulata*, *Chamaesyce cumulicola*, *Coreopsis leavenworthii*, *Croton glandulosus* var. *floridanus*, *Helianthemum nashii*, *Palafoxia feayi*, *Polygonella polygama* var. *brachystachya*, *Rhynchosia cinerea*, and *Stipulicida setacea* var. *lacerata*.

Native Taxa and Natural Habitats

Appendix II represents the 221 to 226 native infrageneric taxa that we inventoried at selected sites within the six main kinds of natural habitats on Marco Island (the number of taxa is approximate because we could not assign species names to certain sterile or otherwise unidentifiable specimens).

Each infrageneric taxon inhabited from one to six of these main kinds of natural habitats (Appendix II). Groups of three numbers are presented; within each group the numbers represent, sequentially: (a) a particular number of habitats (written in script), and (b, c) the number and percentage of the 226 taxa which occupied that number of habitats (indicated with numerals and between parentheses): one (108, 47.8%); two (66, 29.2%); three (29, 12.8%); four (15, 6.6%); five (5, 2.2%); and six (3, 1.3%). These data manifest pronounced negative correlation between the number of habitats occupied and the number of taxa represented. Proceeding stepwise through the data, from one to four habitats, each step entails, roughly, an exponential (ca. two-fold) decrease in the number of taxa.

We designate as especially facultative those 10.2% of taxa that occured in four to six of the main kinds of habitats surveyed. *Chrysobalanus icaco*, *Sabal palmetto*, and *Toxicodendron radicans* inhabited all six kinds. Twenty additional taxa occupied four or five kinds: *Alternanthera flavescens*, *Bursera simaruba*, *Caesalpinea bonduc*, *Coccoloba uvifera*, *Cyperus ligularis*, *Dalbergia ecastaphyllum*, *Ficus* sp., *Fimbristylis cymosa*, *Iresine diffusa*, *Parthenocissus quinquefolia*, *Piscidia piscipula*, *Quercus virginiana*, *Rapanea punctata*, *Serenoa repens*, *Sideroxylon celastrinum*, *Smilax auriculata*, *Tillandsia fasciculata*, *Tillandsia usneoides*, *Vitis rotundifolia*, and *Yucca aloifolia* (Appendix II).

For coastal tropical hardwood hammock and scrubland, the fractions in Appendix II serve as measures of relative frequencies of taxa. For each fraction, the numerator indicates the number of sites of a given habitat that exhibited a particular taxon, the denominator signifies the total number of sites of that habitat evaluated. Thus, a fraction equaling the number one indicates a taxon that occupied all sites studied of a habitat, whereas, fractions of less than one represent taxa present at fewer sites.

Within coastal tropical hardwood hammock, we noted twenty-seven taxa at five to seven (71% to 100%) of the seven sites investigated: *Bursera simaruba*, *Callicarpa americana*, *Chiococca alba*, *Chrysobalanus icaco*, *Chrysophyllum oliviforme, Eugenia axillaris, Ficus aurea, Parthenocissus quinquefolia, Persea borbonia, Phlebodium aureum, Piscidia piscipula, Pleopeltis polypodioides, Psychotria nervosa, Quercus virginiana, Randia aculeata, Rapanea punctata, Rivina humilis, Sabal palmetto, Schoepfia chrysophylloides, Serenoa repens, Sideroxylon celastrinum, Sideroxylon foetidissimum, Tillandsia fasciculata, Tillandsia setacea, Tillandsia usneoides, Toxicodendron radicans,* and *Vitis rotundifolia*. Based on our criterion for relative frequency, we rank these taxa as the most frequent hammock taxa within the sites surveyed. Remaining taxa occupied fewer sites.

Within scrubland, we noted 27 taxa at four to six (67% to 100%) of the six sites investigated: *Bulbostylis ciliatifolia, Bursera simaruba, Cassytha filiformis, Cenchrus spinifex, Chamaecrista fasciculata, Chamaesyce cumulicola, Cyperus retrorsus, Heterotheca subaxillaris, Lyonia fruticosa, Opuntia humifusa, Palafoxia feayi, Polygonella polygama* var. *brachystachya, Psychotria nervosa, Quercus geminata, Quercus myrtifolia, Rhus copallinum, Serenoa repens, Vitis rotundifolia, Callicarpa americana, Licania michauxii, Persea borbonia, Polanisia tenuifolia, Sideroxylon tenax, Smilax auriculata, Tillandsia recurvata, Tillandsia usneoides,* and *Ximenia americana*.

Applying the same criterion as before, we rank these taxa as the most frequent of scrubland taxa within the sites surveyed. Remaining taxa occupied fewer sites.

We did not observe all native taxa of Marco Island at the sites represented in Appendix II. Certain taxa grew within portions of natural habitats outside of these sites. Additional native taxa grew in ruderal habitat or in other kinds of disturbed areas.

FLEPPC Species

The Florida Exotic Pest Plant Council (FLEPPC) recognizes two categories of plant species alien to Florida, that pose especial threats to the ecology of the State, overall, i.e., Category I and Category II (these categories indicate decreasing degree of threat; Florida Exotic Pest Plant Council 2008).

Alien species abound on Marco Island. During the present study, we inventoried 27 Category I species and 19 Category II species (i.e., 40.3 % and 27.1% of all 67 and 70 species in these categories, respectively). Indicated, in Appendix I are all Category I and Category II species that we inventoried on Marco Island.

Taxa Collected by Previous Workers

Previous investigators collected at least 40 infrageneric taxa on Marco Island that we did not observe (appendix I, infrageneric taxa listed with bold font). Eighty five percent of these taxa were native (34 taxa). Four taxa were endemic to Florida: *Lechea cernua, Lechea divaricata, Lechea lakelae,* and *Stylisma abdita*. The 40 taxa constitute 7.8% of all 510 infrageneric taxa reported by us and by previous workers.

Small (1922) also reported *Pinus clausa* and *Persea palustris* (Raf.) Sarg. and Chapman (1878) indicated *Aristida gyrans* n. sp. (at "Robert's Key") and *Pectis ciliaris* L. (at "Collier's Key"); however, neither worker cited voucher specimens.

Rare Taxa Reported Presently and by Previous Investigators

Rare taxa that we (and in some cases, previous investigators) collected include: *Acanthocereus tetragonus, Acrostichum aureum, Chamaescyce cumulicola, Chrysophyllum oliviforme, Clitoria mariana, Myrcianthes fragrans, Scaevola plumieri, Scleria ciliata* var. *curtissii, Tillandsia balbisiana, T. fasciculata, T. flexuosa, T. utriculata, Trichostigma octandrum,* and *Triplasis americana*. Previous workers collected additional rare taxa (Table 2, Appendix I). Table 2 provides assessments of the rarity of these taxa (Coile & Garland 2003; Gann et al. 2002).

Lechea lakelae is the rarest of species previously reported from Marco Island, and is known with certainty solely from there. Olga Lakela first collected *L. lakelae* on the Island in 1964 and participated in most subsequent collecting of that species. The species was last collected on the Island in 1987 (Gann et al. 2002). We failed to locate *L. lakelae*, despite considerable searching, and we suspect that the species is extinct—a victim of development. Probably, other taxa listed in Table 2 have been extirpated from the Island, also.

The presence of wild *Trichostigma octandrum* on Marco Island is noteworthy. Previously unreported from Marco Island, this species of high-climbing vines now grows in at least 15 discrete locations (Table 1). Plants of *T. octandrum* also grow at Otter Mound Preserve and we suspect that at least some were formerly cultivated, based on the regular spacing between them. The wild populations compose two groups on the

Table 2. List of rare plant taxa of Marco Island. Included, are taxa collected both during this study and by previous workers. Rankings of rarity are for Florida (Coile and Garland 2003) and for south Florida (Gann et al. 2002). **Crit. imp.** = critically imperiled; **End.** = endangered; **Hist.** = historical; **Threat.** = threatened.

Taxon	Coile and Garland (2003)	Gann et al. (2002)
Acanthocereus tetragonus	Threat.	
Acrostichum aureum	Threat.	
Amorpha herbacea var. *herbacea*		Hist.
Asclepias tomentosa[1]		Hist.
Cenchrus myosuroides		Crit. imp.
Chamaesyce cumulicola	End.	
Chrysophyllum oliviforme	Threat.	
Clitoria mariana		Crit. imp.
Eleocharis albida		Crit. imp.
Gymnopogon chapmanianus		Crit. imp.
Indigofera trita	End.	Crit. imp.
Lechea cernua	Threat.	
Lechea divaricata	End.	
Lechea lakelae	End.	Hist.
Myrcianthes fragrans	Threat.	
Scaevola plumieri	Threat.	
Scleria ciliata var. *curtissii*		Crit. imp.
Solanum donianum	Threat.	
Stylisma abdita	End.	Crit. imp.
Tillandsia balbisiana	Threat.	
Tillandsia fasciculata	End.	
Tillandsia flexuosa	Threat.	
Tillandsia utriculata	End.	
Trichostigma octandrum	End.	Crit. imp.
Triplasis americana		Crit. imp.
Viola primulifolia		Crit. imp.

[1] After submitting the revised manuscript of this paper we observed one individual of *Asclepias tomentosa* from Marco Island (Wilder & McCombs 29783, a portion of the shoot).

Island: a southern group situated more-or-less near the Preserve, and a medially located group associated with Sheffield Ave. These populations grow in remnants of coastal tropical hardwood hammock and scrubland, on tree island(s) within fields, and within disturbed land (most populations; Table 1).

Trichostigma octandrum exists in Florida at the northern limit of its range, and the species is unknown outside of Florida in the United States. Southward it ranges from Cuba to Venezuela and Peru (Austin 2004). Wunderlin and Hansen (2003) considered *T. octandrum* native to Florida, and Gann et al (2002) ranked this species as Critically Imperiled in south Florida. Austin (2004), however, concluded that "we do not know" whether *T. octandrum* is native or alien in Florida.

Previous workers had reported *T. octandrum* from five sites in Florida. In 1891 Joseph H. Simpson first discovered the species on Chokoloskee Island (Collier Co.), a location ca. 23 miles from Marco Island (as measured from the Caxambas region of Marco Island). Investigators subsequently located it on Pumpkin Key (Monroe Co.), in Miami (Miami-Dade Co.), and in the Big Cypress National Preserve (county unspecified). In 2000, Michael Anderson discovered the species in Water Conservation Area 3A (Broward Co.; Gann et al. 2002). Gann et al. (2002), citing habitat destruction at various locations, considered the plants at Conservation Area 3A as "... apparently the only extant occurrence in Florida."

An unpublished discovery of one plant of *T. octandrum* was made on a shell mound at Everglades National Park, by Jesse Hoffmann (Jimi Sadle, pers. comm., 28 Jan 2009; Sadle vouchered this individual [*J. Sadle 553*, FNPS]).

We do not know whether *Trichostigma octandrum* is native to Marco Island. Perhaps, the wild populations there are escapes from the apparently cultivated individuals at Otter Mound Preserve. The absence of previous reports/collections of *T. octandrum* from Marco Island suggests that the wild plants are not original. In contrast, the proximity of Marco Island to Chokoloskee Island suggests that the species might be native to Marco Island. If *T. octandrum* is native on Marco Island, then plants growing at the Preserve may have been acquired from nature on Marco Island, or they may be the offspring of wild plants there.

Chamaesyce cumulicola, *Myrcianthes fragrans*, and *Scaevola plumieri* are fairly common on Marco Island, yet, Coile and Garland (2003), the Florida Natural Areas Inventory (2008), and Gann et al. (2002), collectively, considered these species rare in South Florida.

Many native species are rare on Marco Island that vary from rare to common in Florida. Native species with one to ca. several individuals observed on the Island during this study include *Acanthocereus tetragonus*, *Acer rubrum*, *Andropogon ternarius*, *Aristida condensata*, *Asimina reticulata*, *Baccharis angustifolia*, *Bucida buceras*, *Capparis cynophallophora*, *Capparis flexuosa*, *Capsicum annuum*, *Carex longii*, *Chrysopogon pauciflorus*, *Chrysopsis scabrella*, *Clitoria mariana*, *Hamelia patens*, *Helianthemum nashii*, *Heliotropium curassavicum*, *Herissantia crispa*, *Hymenocallis latifolia*, *Ipomoea sagittata*, *Lechea sessiliflora*, *Liatris tenuifolia*, *Neptunia pubescens*, *Osmunda regalis*, *Parietaria floridana*, *Pentalinon luteum*, *Pisonia aculeata*, *Pluchea carolinensis*, *Polystachya concreta*, *Psilotum nudum*, *Scleria ciliata* var. *curtissii*, *Seymeria pectinata*, *Smilax bona-nox*, *Sorghastrum secundum*, *Thelypteris kunthii*, *Tournefortia volubilis*, and *Vaccinium myrsinites*.

CONCLUSIONS

Marco Island exhibits fewer wild taxa than one might expect on the basis of its considerable area and subtropical character. We attribute the apparent deficit of taxa to the extensive development of the Island and to the elimination of fresh water wetlands, saltwater marshes, and original pine flatwoods.

The Island flora exhibits/exhibited striking differences from the floras of adjacent portions of mainland Collier County. **(1)** *Persea borbonia* is frequent on Marco Island, yet, we have never observed it in mainland Collier County. **(2)** *Sideroxylon tenax* is abundant on Marco Island but is absent or uncommon within mainland Collier County. **(3)** *Sideroxylon reclinatum* is frequent in mainland Collier County, but is absent from Marco Island. **(4)** *Prunus caroliniana* composes one disjunct, albeit ample population on Marco Island, located within scrubland. We do not know whether the population is native. Within eastern Florida, the nearest populations of *P. caroliniana* occur three counties northward (in De Soto Co. and Sarasota Co.; Wunderlin and Hansen, 2008). **(5)** Since its discovery in 1964, *Lechea lakelae* has been known unequivocally, solely, from Marco Island.

APPENDIX I [1]

List of taxa documented for Marco Island (plus *Cocos nucifera* L., which was recorded but not documented during this study). Nonbold font signifies infrageneric taxa (species, a hybrid, subspecies, and varieties) documented during the present investigation. Infrageneric taxa that previous workers documented but that were not observed during the present study are listed with bold font. Solely one voucher specimen represents each infrageneric taxon. For infrageneric taxa documented during this study, data are presented as follows after the Latin name of a taxon: relevant synonym, if any (between brackets); common name; the Wilder and McCombs collection number[2] of a voucher specimen; the habitat where the specimen was collected; and the designation of the taxon, if any, by the Florida Exotic Plant Pest Council. For infrageneric taxa documented solely by previous investigators, data are provided as follows after the Latin name of a taxon: relevant synonym, if any (between brackets); common name; collector; collection number; collection date; and acronym of the herbarium where the specimen is on deposit.[3] After the name of each family and suprafamilial taxon, between parentheses are included two or four numbers; the two numbers not in italics—if present—signify, respectively, the numbers reported presently of genera and infrageneric taxa within that family or suprafamilial taxon; the two numbers in italics—if present—signify, respectively, the sums of numbers reported presently and by previous workers, of such genera and infrageneric taxa. * = alien to Florida; ¤ = endemic to Florida; FLEPPC I and FLEPPC II = taxa recognized as Category I or Category II species by the Florida Exotic Plant Pest Council (2008).

PTERIDOPHYTES (13, 19)

BLECHNACEAE (2, 2)

Blechnum serrulatum Rich., Swamp Fern—28501; pine flatwoods

Woodwardia virginica (L.) Sm., Virginia Chain Fern—28505; pine flatwoods

DENNSTAEDTIACEAE (1, 2)

Pteridium aquilinum var. *caudatum* (L.) Sadeb., Lacy Bracken—28445; edge of scrubland

Pteridium aqulinum var. *pseudocaudatum* (Clute) Clute ex A. Heller, Tailed Bracken—28503; coastal tropical hardwood hammock

LYGODIACEAE (1, 1)

Lygodium microphyllum* (Cav.) R. Br., Old World Climbing Fern—28689; climbing on other vegetation rooted in shallow water of Marco Lake; FLEPPC **I

NEPHROLEPIDACEAE (1, 4)

**Nephrolepis biserrata* (Sw.) Schott cultivar—29137; periphery of oak-*Sabal* hammock

Nephrolepis cordifolia* (L.) C. Presl, Tuberous Sword Fern—28437; scrubland; FLEPPC **I

Nephrolepis exaltata (L.) Schott, Sword Fern—27875; coastal tropical hardwood hammock

Nephrolepis multiflora* (Roxb.) F.M. Jarrett ex C.V. Morton, Asian Sword Fern—28752; coastal tropical hardwood hammock; FLEPPC **I

OSMUNDACEAE (1, 1)

Osmunda regalis L., Royal Fern—28489; pine flatwoods

POLYPODIACEAE (2, 2)

Phlebodium aureum (L.) J. Sm., Golden Polypody—28502; pine flatwoods

Pleopeltis polypodioides (L.) E.G. Andrews & Windham, Resurrection Fern—27599; coastal tropical hardwood hammock

PSILOTACEAE (1, 1)

Psilotum nudum (L.) P. Beauv., Whisk-Fern—28751; along boardwalk traversing woody-plant zone of coastal strand vegetation

PTERIDACEAE (2, 3)

Acrostichum aureum L., Golden Leather Fern—28407; along boardwalk traversing mangrove habitat

Acrostichum danaeifolium Langsd. & Fisch., Giant Leather Fern—28408; at/near periphery of mangrove habitat

Pteris vittata* L., Chinese Ladder Brake—28490; periphery of coastal tropical hardwood hammock; FLEPPC **II

THELYPTERIDACEAE (1, 2)

Thelypteris interrupta (Willd.) K. Iwats., Hottentot Fern—28931; by shore of Marco Lake

Thelypteris kunthii (Desv.) C.V. Morton, Southern Shield Fern—28551; disturbed land

VITTARIACEAE (1, 1)

Vittaria lineata (L.) Sm., Shoestring Fern—27874; coastal tropical hardwood hammock

GYMNOSPERM (1, 1)

PINACEAE (1, 1)

Pinus elliottii Engelm., Slash Pine—28479; pine flatwoods

MONOCOTYLEDONS (67, 134; *73, 147*)

AGAVACEAE (2, 4)

¤*Agave decipiens* Baker, False Sisal—28594; disturbed land

Agave sisalana* Perrine, Sisal Hemp—28561; coastal strand vegetation; FLEPPC **II

**Agave vivipara* L., Century Plant—27994; scrubland

Yucca aloifolia L., Spanish Bayonet—28726; coastal strand vegetation

ALISMATACEAE (1, 1)

Sagittaria lancifolia L., Bulltongue Arrowhead—28943; by shore of Marco Lake

AMARYLLIDACEAE (2, 3)

Crinum americanum L., String-Lily—28742; coastal tropical hardwood hammock

**Crinum asiaticum* L., Poisonbulb—28727; scrubland

Hymenocallis latifolia (Mill.) M. Roem., Mangrove Spider-lily—28728; herbaceous zone of coastal strand vegetation

ARACEAE (2, 2)

Epipremnum pinnatum* (L.) Engl., Golden Pothos—29172; coastal tropical hardwood hammock; FLEPPC **II

Syngonium podophyllum* Schott, American Evergreen—28944; disturbed land; FLEPPC **I

ARECACEAE (3, 3)

**Cocos nucifera* L., Coconut Palm – coconut with attached seedling, on beach

Sabal palmetto (Walter) Lodd. ex Schult. & Schult. f., Cabbage Palm—29212; disturbed remnant of pine flatwoods

Serenoa repens (W. Bartram) Small, Saw Palmetto—28625; pine flatwoods

ASPARAGACEAE (1, 1)

Asparagus aethiopicus* L., Sprenger's Asparagus-Fern—28663; coastal strand vegetation; FLEPPC **I

BROMELIACEAE (1, 8)

Tillandsia balbisiana Schult. & Schult. f., Northern Needleleaf—27934; coastal tropical hardwood hammock

Tillandsia fasciculata Sw., Cardinal Airplant—29213; coastal tropical hardwood hammock

Tillandsia flexuosa Sw., Twisted Airplant—27646; coastal tropical hardwood hammock

Tillandsia paucifolia Baker, Potbelly Airplant—28005; disturbed land

Tillandsia recurvata (L.) L., Ballmoss—28006

Tillandsia setacea Sw., Southern Needleleaf—27766; disturbed land

Tillandsia usneoides (L.) L., Spanish Moss—28271; scrubland

Tillandsia utriculata L., Giant Airplant—29214; found lying on forest floor

CANNACEAE (*1, 1*)

****Canna ×generalis* L.H. Bailey, Garden Canna, Olga Lakela 29067 with D. Laker; 20 Aug 1965 (USF)**

COMMELINACEAE (2, 4)

**Commelina diffusa* Burm. f., Dayflower—28419; disturbed land

Commelina erecta L., Whitemouth Dayflower—28597; disturbed land

**Tradescantia pallida* (Rose) D.R. Hunt, Purplequeen—28420; disturbed land

**Tradescantia zebrina* Bosse, Wandering-Jew—28820; coastal tropical hardwood hammock

CYMODOCEACEAE (1, 1)

Halodule wrightii Asch., Shoalweed—28814; shallow water of bay

CYPERACEAE (11, 34; *11, 37*)

**Bulbostylis barbata* (Rottb.) C.B. Clarke, Watergrass—28805; highly insolated, cleared land

Bulbostylis ciliatifolia (Elliott) Fernald, Capillary Hairsedge—28320; scrubland

Bulbostylis stenophylla (Elliott) C.B. Clarke, Sandyfield Hairsedge—28938; scrubland

Carex longii Mack., Long's Sedge—28449; highly insolated lawn

Cladium jamaicense Crantz, Jamaica Swamp Sawgrass—28513; pine flatwoods

Cyperus compressus L., Poorland Flatsedge—29103; highly insolated lawn

Cyperus croceus Vahl, Baldwin's Flatsedge—29045; disturbed land

**Cyperus esculentus* L., Yellow Nutgrass—28819; highly insolated, cleared land

Cyperus flavescens L., Yellow Flatsedge—28900; wet portion of highly insolated tree lawn

Cyperus haspan L., Haspan Flatsedge—29167; insolated shore of Marco Lake

Cyperus ligularis L., Swamp Flatsedge—29047; herbaceous zone of coastal strand vegetation

Cyperus odoratus L., Fragrant Flatsedge—29136; oak-*Sabal* hammock

Cyperus polystachyos Rottb., Manyspike Flatsedge—29106; highly insolated lawn

**Cyperus pumilus* L.; Low Flatsedge—29168; boundary between lawn and brackish wetland

Cyperus retrorsus Chapm., Pinebarren Flatsedge—29081; scrubland

**Cyperus rotundus* L., Nutgrass—28499; tree lawn

**Cyperus sphacelatus* Rottb., Roadside Flatsedge—28994; highly insolated lawn

***Cyperus squarrosus* L., Bearded Flatsedge, Olga Lakela 29238, 1965 (NY, USF)**

Cyperus surinamensis Rottb., Tropical Flatsedge—29108; in ditch situated within highly insolated ruderal land

Cyperus tetragonus Elliott, Fourangle Flatsedge—28854; shaded, overgrown scrubland

***Eleocharis albida* Torr., White Spikerush, Olga Lakela 30960, 1967 (USF)**

***Eleocharis baldwinii* (Torr.) Chapm., Baldwin's Spikerush, Olga Lakela 31680, 21 Sep, 1968 (USF)**

Eleocharis cellulosa Torr., Gulf Coast Spikerush—28809; insolated portion of mangrove habitat

Eleocharis geniculata (L.) Roem. & Schult., Canada Spikerush—28626; highly insolated lawn

Eleocharis interstincta (Vahl) Roem. & Schult., Knotted Spikerush—28810; by shore of Marco Lake

Fimbristylis caroliniana (Lam.) Fernald; Carolina Fimbry—28811; herbaceous zone of coastal strand vegetation

Fimbristylis cymosa R. Br., Hurricanegrass—28418; herbaceous zone of coastal strand vegetation

Fimbristylis spadicea (L.) Vahl, Marsh Fimbry—28813; herbaceous zone of coastal strand vegetation

Fuirena scirpoidea Michx., Southern Umbrellasedge—28939; by shore of Marco Lake

**Kyllinga brevifolia* Rottb., Shortleaf Spikesedge—28903; shrub bed

**Kyllinga squamulata* Thonn. ex Vahl; Asian Spikesedge—29170; lawn

**Lipocarpha aristulata* (Coville) G.C. Tucker, Awned Halfchaff Sedge—28857; wet portion of lawn

Lipocarpha micrantha (Vahl) G.C. Tucker, Smallflower Halfchaff Sedge—29201; woody-plant zone of coastal strand vegetation

Rhynchospora colorata (L.) H. Pfeiff. [*Dichromena colorata* (L.) Hitchc.], Starrush Whitetop—28514; herbaceous zone of coastal strand vegetation

Rhynchospora megalocarpa A. Gray, Sandyfield Beaksedge—28940; scrubland

Scleria ciliata var. *curtissii* (Britton ex Small) J.W. Kessler, Curtiss' Nutrush—28942; scrubland

Scleria triglomerata Michx., Tall Nutgrass—28500; scrubland

DIOSCOREACEAE (1, 1)

**Dioscorea bulbifera* L., Air-Potato—28821; on mangrove vegetation by parking lot; FLEPPC I

IRIDACEAE (*1, 1*)

***Sisyrinchium angustifolium* Mill., Narrowleaf Blue-Eyed Grass, F.C. Craighead sn, 24 Mar 1964 (FTG)**

JUNCACEAE (1, 1; *1, 2*)

Juncus marginatus Rostk., Shore Rush—28948; by shore of Marco Lake

***Juncus repens* Michx., Lesser Creeping Rush, Olga Lakela 30847, date unspecified (USF)**

ORCHIDACEAE (3, 3)

Encyclia tampensis (Lindl.) Small, Florida Butterfly Orchid—29109; coastal tropical hardwood hammock

**Oeceoclades maculata* (Lindl.) Lindl., Monk Orchid—28450; edge of tropical hardwood hammock

Polystachya concreta (Jacq.) Garay & H.R. Sweet, Greater Yellowspike Orchid—29049; tropical hardwood hammock

POACEAE (33, 64; *36, 70*)

Amphicarpum muhlenbergianum (Schult.) Hitchc., Blue Maidencane—29165; disturbed land

Andropogon glomeratus (Walter) Britton et al., Bushy Bluestem—29069; edge of scrubland

Andropogon ternarius Michx., Splitbeard Bluestem—29070; edge of scrubland

Andropogon virginicus L., Broomsedge Bluestem—28980; herbaceous zone of coastal strand vegetation

Andropogon virginicus var. _glaucus_ Hack., Chalky Bluestem, Olga Lakela 31192; 22 Oct 1967 (USF)

Aristida condensata Chapm., Big Threeawn—28933; edge of scrubland

Aristida patula Chapm. ex Nash, Tall Threeawn—28410; highly insolated, disturbed land

Aristida purpurascens Poir. var. _purpurascens_, Arrowfeather Threeawn—28889; Scrubland

Axonopus fissifolius (Raddi) Kuhlm., Common Carpetgrass, Olga Lakela 31373; 7 Apr 1968 (USF)

*_Bothriochloa pertusa_ (L.) A. Camus, Pitted Beardgrass—28552; highly insolated, disturbed land

Cenchrus echinatus L., Southern Sandbur—28753; boundary between mangrove habitat and parking lot

Cenchrus myosuroides Kunth, Big Sandbur, Joseph H. Simpson 281, 1891 (US)

Cenchrus spinifex Cav. [Cenchrus incertus M.A. Curtis], Coastal Sandbur—29042; herbaceous zone of coastal strand vegetation

Chrysopogon pauciflorus (Chapm.) Benth. ex Vasey, Florida False Beardgrass—29043; disturbed land bordering coastal strand vegetation and mangrove habitat

*_Cynodon dactylon_ (L.) Pers., Bermudagrass—28447; disturbed, overgrown portion of beach

*_Dactyloctenium aegyptium_ (L.) Willd. ex Asch. & Schweinf., Durban Crowfootgrass—28657; disturbed, overgrown portion of beach

Dichanthelium aciculare (Desv. ex Poir.) Gould & C.A. Clark, Needleleaf Witchgrass—28934; scrubland

Dichanthelium commutatum (Schult.) Gould, Variable Witchgrass—28890; edge of tropical hardwood hammock

*_Digitaria bicornis_ (Lam.) Roem. & Schult., Asia Crabgrass—28658; disturbed, overgrown portion of beach

Digitaria ciliaris (Retz.) Koeler var. _ciliaris_, Southern Crabgrass—28283; highly insolated cleared land

Digitaria filiformis (L.) Koeler var. _villosa_ (Walter) Fernald, Slender Crabgrass—28554; highly insolated ruderal land

*_Digitaria longiflora_ (Retz.) Pers., Indian Crabgrass—28556; highly insolated, cleared land

Distichlis spicata (L.) Greene, Saltgrass—28981; edge of mangrove habitat

Echinochloa walteri (Pursh) A. Heller, Coast Cockspur—28507; highly insolated, cleared land

*_Eleusine indica_ (L.) Gaertn., Indian Goosegrass—28659; disturbed, overgrown portion of beach

*_Eragrostis amabilis_ (L.) Wight & Arn. ex Hook. & Arn., Feather Lovegrass—28714; crack in pavement of road

*_Eragrostis atrovirens_ (Desf.) Trin. ex Steud., Thalia Lovegrass—27658; disturbed land

*_Eragrostis ciliaris_ (L.) R. Br., Gophertail Lovegrass—28284; ruderal land

Eragrostis elliottii S. Watson, Elliott's Lovegrass—29075; herbaceous zone of coastal strand vegetation

Eragrostis secundiflora J. Presl, Red Lovegrass—28892; field

*_Eremochloa ophiuroides_ (Munro) Hack., Centipedegrass—28894; ruderal land

Eustachys petraea (Sw.) Desv., Pinewoods Fingergrass—28553; tree lawn

Gymnopogon chapmanianus Hitchc., Chapman's Skeletongrass, Olga Lakela 27527, 1967 (FLAS, USF)

*_Hemarthria altissima_ (Poir.) Stapf & C.E. Hubb., Limpograss—28717; highly insolated tree lawn; FLEPPC **II**

Heteropogon contortus (L.) P. Beauv. ex Roem. & Schult., Tanglehead—28509; field

Leptochloa fusca subsp. _fascicularis_ (Lam.) N. Snow, Bearded Sprangletop—28718; highly insolated ruderal land

Muhlenbergia capillaris var. _filipes_ (M.A. Curtis) Chapm. ex Beal, Gulf Hairawn Muhly—29076; herbaceous zone of coastal strand vegetation

Oplismenus hirtellus (L.) P. Beauv., Woodsgrass—28754; coastal tropical hardwood hammock

Panicum amarum Elliott, Bitter Panicgrass—28852; herbaceous zone of coastal strand vegetation

*_Panicum maximum_ Jacq., Guineagrass—29100; highly insolated, disturbed land; FLEPPC **II**

*_Panicum repens_ L., Torpedograss—28510; tree lawn; FLEPPC **I**

Panicum virgatum L., Switchgrass—29166; shaded, disturbed land

*_Paspalum nicorae_ Parodi, Brunswickgrass—28897; field

*_Paspalum notatum_ Flüggé var. _notatum_, Bahiagrass—28628; overgrown tree lawn

*_Paspalum notatum_ var. _saurae_ Parodi, Bahiagrass—28491; edge of scrubland

Paspalum setaceum var. _ciliatifolium_ (Michx.) Vasey, Fringeleaf Paspalum; nonstereotypical material—28268; scrubland

Paspalum setaceum var. _longipedunculatum_ (Leconte) A.W. Wood, Barestem Paspalum, Olga Lakela 31083, 8 Sep 1967 (USF)

Paspalum setaceum var. _rigidifolium_ (Nash) D.J. Banks, Stiff Paspalum—29016; scrubland

Paspalum setaceum var. _stramineum_ (Nash) D.J. Banks, Yellow Sand Paspalum; 29017; scrubland

Paspalum setaceum var. _villosissimum_ (Nash) D.J. Banks, Hairy Paspalum; 28721; scrubland

*_Paspalum urvillei_ Steud., Vaseygrass; 28987; highly insolated lawn

Paspalum vaginatum Sw., Seashore Paspalum; 28723; herbaceous zone of coastal strand vegetation

***_Pennisetum purpureum_ Schumach., Elephantgrass, Olga Lakela 29244, 6 Oct 1965 (USF)**

Phragmites australis (Cav.) Trin. ex Steud., Common Reed—29018; ruderal land

*_Rhynchelytrum repens_ (Willd.) C.E. Hubb., Rose Natalgrass—28319; scrubland; FLEPPC I

Setaria corrugata (Elliott) Schult., Coastal Bristlegrass—29077; edge of scrubland

Setaria macrosperma (Scribn. & Merr.) K. Schum., Coral Bristlegrass—28936; disturbed land

Setaria parviflora (Poir.) Kerguelén, Yellow Bristlegrass—29102; highly insolated, disturbed land

Sorghastrum secundum (Elliott) Nash, Lopsided Indiangrass—29078; edge of scrubland

Spartina patens (Aiton) Muhl., Marshhay Cordgrass—29199; herbaceous zone of coastal strand vegetation

**Sporobolus diandrus* (Retz.) P. Beauv., Dropseed (possibly, *S. jacquemontii*)—28511; highly insolated cleared land

Sporobolus domingensis (Trin.) Kunth, Coral Dropseed—28988; herbaceous zone of coastal strand vegetation

Sporobolus virginicus (L.) Kunth, Seashore Dropseed—28416; herbaceous zone of coastal strand vegetation

Stenotaphrum secundatum (Walter) Kuntze, St. Augustinegrass—29019; insolated ruderal land

Triplasis americana P. Beauv., Perennial Sandgrass—28937; scrubland

Triplasis purpurea (Walter) Chapm., Purple Sandgrass—28989; herbaceous zone of coastal strand vegetation

Uniola paniculata L., Seaoats—28559; herbaceous zone of coastal strand vegetation

Urochloa adspersa (Trin.) R.D. Webster, Dominican Signalgrass—29022; periphery of Oak-Sabal hammock

**Urochloa fusca* (Sw.) B.F. Hansen & Wunderlin, Browntop Signalgrass—28804; field

**Urochloa subquadripara* (Trin.) R.D. Webster, Armgrass Millet—28853; edge of coastal tropical hardwood hammock

RUSCACEAE (1, 1)

Sansevieria hyacinthoides* (L.) Druce, Bowstring Hemp—28995; disturbed land; FLEPPC **II

SMILACACEAE (1, 2)

Smilax auriculata Walter, Earleaf Greenbrier—28287; scrubland

Smilax bona-nox L., Saw Greenbrier—28822; edge of coastal tropical hardwood hammock

TYPHACEAE (1, 1)

Typha domingensis Pers., Southern Cattail—29320; edge of large pond at Mackle Park

XYRIDACEAE (*1, 1*)

***Xyris brevifolia* Michx., Shortleaf Yelloweyed Grass, Olga Lakela 31371, 7 Apr 1968 (FTG)**

DICOTYLEDONS (243, 316; *260, 343*)

ACANTHACEAE (2, 2)

Blechum pyramidatum* (Lam.) Urb., Browne's Blechum—28451; lawn; FLEPPC **II

Ruellia brittoniana* Leonard, Mexican Bluebell—28782; disturbed land; FLEPPC **I

ACERACEAE (1, 1)

Acer rubrum L., Red Maple—28516; pine flatwoods

AIZOACEAE (1, 1)

Sesuvium portulacastrum (L.) L., Shoreline Seapurslane —28074; mangrove habitat

AMARANTHACEAE (5, 8)

Alternanthera flavescens Kunth, Yellow Joyweed—27661; periphery of shell mound

Amaranthus australis (A. Gray) J.D. Sauer, Southern Amaranth —28598; dried-up water retention pond

**Amaranthus blitum* L., Purple Amaranth—28904; cultivated land

**Amaranthus hybridus* L., Slim Amaranth—28517; highly insolated, cleared land

**Amaranthus viridis* L., Slender Amaranth—28566; highly insolated, ruderal land

Blutaparon vermiculare (L.) Mears, Samphire—28461; disturbed, overgrown portion of beach

Froelichia floridana (Nutt.) Moq., Cottonweed—28518; scrubland

Iresine diffusa Humb. & Bonpl. ex Willd., Juba's Bush—28520; herbaceous zone of coastal strand vegetation

ANACARDIACEAE (4, 4)

**Mangifera indica* L., Mango—27878; coastal tropical hardwood hammock

Rhus copallinum L., Winged Sumac—28785; scrubland

Schinus terebinthifolius* Raddi, Brazilian Pepper—28567; edge of coastal tropical hardwood hammock; FLEPPC **I

Toxicodendron radicans (L.) Kuntze, Eastern Poison Ivy—27879; coastal tropical hardwood hammock

ANNONACEAE (1, 1)

¤*Asimina reticulata* Shuttlew. ex Chapm., Netted Pawpaw—29517; road-facing edge of scrubland

APIACEAE (1, 1)

Ptilimnium capillaceum (Michx.) Raf., Mock Bishopsweed—29111; in ditch situated within highly insolated ruderal land

APOCYNACEAE (3, 3)

**Catharanthus roseus* (L.) G. Don, Madagascar Periwinkle – both white-flowered forma and pink-flowered forma—29140; disturbed land

Pentalinon luteum (L.) B.F. Hansen & Wunderlin, Wild Allamanda—28692; coastal strand vegetation

Rhabdadenia biflora (Jacq.) Mull. Arg., Rubbervine—27880; mangrove habitat

AQUIFOLIACEAE (*1, 1*)

***Ilex glabra* (L.) A. Gray, Inkberry, Olga Lakela 30795 with F. Almeda, 20 Apr 1967 (USF)**

ARALIACEAE (3, 3)

Centella asiatica (L.) Urb., Spadeleaf—28452; overgrown tree lawn

Hydrocotyle umbellata L., Manyflower Marshpennywort—28786; highly insolated, overgrown tree lawn

Schefflera actinophylla* (Endl.) Harms, Australian Umbrella Tree—28860; coastal tropical hardwood hammock; FLEPPC **I

ASCLEPIADACEAE (4, 4; *4, 5*)

**Asclepias curassavica* L., Scarlet Milkweed—28422; disturbed land

***Asclepias tomentosa* Elliott, Velvetleaf Milkweed; Harold N. Moldenke 5904, 1930 (NY)**

Cryptostegia madagascariensis* Bojer ex Decne., Madagascar Rubbervine—29202; amidst mangrove vegetation situated at roadside; FLEPPC **II

Cynanchum angustifolium Pers., Gulf Coast Swallowwort—28521; herbaceous zone of coastal strand vegetation

Sarcostemma clausum (Jacq.) Roem. & Schult., White Twinevine—28453; highly insolated, cleared land

ASTERACEAE (35, 42; *36, 44*)

Ageratina jucunda (Greene) Clewell & Wooten, Hammock Snakeroot—29113; scrubland

Ambrosia artemisiifolia L., Common Ragweed—28454; disturbed, overgrown portion of beach

Baccharis angustifolia Michx., Saltwater Falsewillow—28905; boundary between mangrove habitat and ruderal land

Baccharis glomeruliflora Pers., Silverling—29050; pine flatwoods

Baccharis halimifolia L., Groundsel Tree—29203; woody-plant zone of coastal strand vegetation

Bidens alba (L.) DC., Beggerticks—28522; tree lawn

Borrichia frutescens (L.) DC., Bushy Seaside Oxeye—29204; edge of mangrove habitat

**Calyptocarpus vialis* Less., Straggler Daisy—28906; lawn

Chrysopsis scabrella Torr. & A. Gray, Coastalplain Goldenaster—29115; scrubland

Cirsium nuttallii DC., Nuttall's Thistle—29116; highly insolated lawn

Conyza canadensis (L.) Cronquist, Canadian Horseweed—29141; ruderal land

¤*Coreopsis leavenworthii* Torr. & A. Gray, Leavenworth's Tickseed—28523; highly insolated, cleared land

**Cyanthillium cinereum* (L.) H. Rob., Little Ironweed—28862; field

Eclipta prostrata (L.) L., False Daisy—29117; in ditch situated within highly insolated ruderal land

**Emilia fosbergii* Nicolson, Florida Tasselflower—28455; developed land

**Emilia sonchifolia* (L.) DC., Lilac Tasselflower—28569; tree lawn

***Erechtites hieraciifolius* (L.) Raf. ex DC., Fireweed, Olga Lakela 29441, 10 Jan 1966 (USF)**

Erigeron quercifolius Poir., Oakleaf Fleabane—28456; overgrown tree lawn

Eupatorium capillifolium (Lam.) Small ex Porter & Britton, Dogfennel—28865; disturbed land

Eupatorium serotinum Michx., Lateflowering Thoroughwort—28423; adjacent to boardwalk through mangrove habitat

Flaveria linearis Lag., Narrowleaf Yellowtops—28570; woody-plant zone of coastal strand vegetation

Gaillardia pulchella Foug., Firewheel—29205; herbaceous zone of coastal strand vegetation

Gamochaeta pensylvanica (Willd.) Cabrera, Pennsylvania Everlasting—29518; yard

Helianthus debilis Nutt. subsp. *debilis*, East Coast Dune Sunflower—28424; scrubland

Heterotheca subaxillaris (Lam.) Britton & Rusby, Camphorweed—28272; scrubland

Iva imbricata Walter, Seacoast Marshelder—28695; herbaceous zone of coastal strand vegetation

Liatris tenuifolia Nutt., Shortleaf Gayfeather—29162; edge of scrubland

Melanthera nivea (L.) Small, Snow Squarestem—28667; edge of overgrown lawn

Mikania scandens (L.) Willd., Climbing Hempvine—28323; disturbed land

¤*Palafoxia feayi* A. Gray, Feay's Palafox—28973; scrubland

Pectis prostrata Cav., Spreading Cinchweed—28788; tree lawn

Pityopsis graminifolia (Michx.) Nutt., Narrowleaf Silkgrass—28696; highly insolated land

Pluchea carolinensis (Jacq.) G. Don, Cure-For-All—29143; oak-*Sabal* hammock

Pluchea odorata (L.) Cass., Sweetscent—29118; highly insolated lawn

Pluchea rosea R.K. Godfrey, Rosy Camphorweed—28951; shore of Marco Lake

Solidago odora Aiton, Goldenrod—28697; scrubland

Solidago sempervirens L., Seaside Goldenrod—28530; cleared land

***Solidago tortifolia* Elliott, Twistedleaf Goldenrod, Alvan W. Chapman sn, middle to late 1800s (US)**

**Sonchus oleraceus* L., Common Sowthistle—28599; shell mound

Sphagneticola trilobata* (L.) Pruski [Wedelia trilobata [L.] Hitchc.], Creeping Oxeye—29119; highly insolated lawn; FLEPPC **II

Symphyotrichum subulatum (Michx.) G.L. Nesom, Annual Saltmarsh Aster—29114; in ditch situated within highly insolated ruderal land

**Tridax procumbens* L., Coatbuttons—28457; highly insolated, ruderal land

Verbesina virginica L., White Crownbeard—28525; boundary between mangrove habitat and highly insolated cleared land

**Youngia japonica* (L.) DC., Oriental False Hawksbeard—28600; lawn

AVICENNIACEAE (1, 1)

Avicennia germinans (L.) L., Black Mangrove—28630; disturbed, overgrown portion of beach

BASELLACEAE (1, 1)

**Anredera vesicaria* (Lam.) Gaertn. f., Texas Madeiravine—29224; climbing on clump of vegetation within field

BATACEAE (1, 1)

Batis maritima L., Saltwort—28438; periphery of mangrove habitat

BIGNONIACEAE (2, 3)

**Pyrostegia venusta* (Ker Gawl.) Miers, Flamevine—29232; disturbed scrubland

**Tecoma capensis* (Thunb.) Lindl., Cape Honeysuckle—28458; coastal tropical hardwood hammock

**Tecoma stans* (L.) Juss. ex Kunth, Yellow Elder—27669; Indian Hill (a dune)

BORAGINACEAE (2, 4)

Heliotropium angiospermum Murray, Scorpionstail—29144; oak-*Sabal* hammock

Heliotropium curassavicum L., Seaside Heliotrope—28823; boundary between mangrove habitat and parking lot

Heliotropium polyphyllum Lehm., Pineland Heliotrope—28526; scrubland

Tournefortia volubilis L., Twining Soldierbush—28825; edge of coastal tropical hardwood hammock

BRASSICACEAE (1, 1)

Lepidium virginicum L., Virginia Pepperweed—28572; tree lawn

BURSERACEAE (1, 1)

Bursera simaruba (L.) Sarg., Gumbo-Limbo—27691; coastal tropical hardwood hammock

CACTACEAE (2, 3; *2, 4*)

Acanthocereus tetragonus (L.) Hummelinck, Barbed-Wire Cactus—29218; disturbed land

**Opuntia cochenillifera* (L.) Mill., Cochineal Cactus—29223; disturbed land

Opuntia humifusa (Raf.) Raf., Pricklypear—28291; scrubland

***Opuntia stricta* (Haw.) Haw., Erect Pricklypear, Olga Lakela 28540, 1 May 1965 (USF)**

CAPPARACEAE (2, 3)

Capparis cynophallophora L., Jamaican Capertree—29145; periphery of coastal tropical hardwood hammock

Capparis flexuosa (L.) L., Bayleaf Capertree—28864; coastal tropical hardwood hammock

Polanisia tenuifolia Torr. & A. Gray, Slenderleaf Clammyweed—28601; scrubland

CARICACEAE (1, 1)

**Carica papaya* L., Papaya—27965; coastal tropical hardwood hammock

CARYOPHYLLACEAE (2, 2)

Paronychia americana (Nutt.) Frenzl ex Walp., American Nailwort—28602; scrubland

¤*Stipulicida setacea* var. *lacerata* C.W. James, Pineland Scalypink—28952; scrubland

CASUARINACEAE (1, 1)

Casuarina equisetifolia* L., Australian-Pine—28528; disturbed land; FLEPPC **I

CELASTRACEAE (1, 1)

Hippocratea volubilis L., Medicine Vine—27884; coastal tropical hardwood hammock

CELTIDACEAE (1, 1; *2, 2*)

***Celtis laevigata* Willd., Hackberry, Olga Lakela 28519A; 1 May 1965 (USF)**

Trema micranthum (L.) Blume, Nettle Tree—28548; disturbed land

CHENOPODIACEAE (4, 5)

Atriplex cristata Humb. & Bonpl. ex Willd., Crested Saltbush—28622; herbaceous zone of coastal strand vegetation

**Chenopodium ambrosioides* L., Mexican Tea—28292; highly insolated, cleared land

Chenopodium berlandieri Moq., Pitseed Goosefoot—28531; highly insolated, cleared land

Sarcocornia perennis (Mill.) A.J. Scott, Perennial Glasswort—28796; along boardwalk through mangrove habitat

Suaeda linearis (Elliott) Moq., Sea Blite—28462; disturbed, overgrown portion of beach

CHRYSOBALANACEAE (2, 2)

Chrysobalanus icaco L. (including the forma with purple fruits and the forma with white fruits), Coco Plum—27671; coastal tropical hardwood hammock

Licania michauxii Prance, Gopher Apple—28273; scrubland

CISTACEAE (2, 2; *2, 5*)

¤*Helianthemum nashii* Britton, Florida Scrub Frostweed—28797; highly insolated sand

¤*Lechea cernua* Small, Nodding Pinweed; Olga Lakela 31974, 30 Dec 1969 (USF)

¤*Lechea divaricata* Shuttlew. ex Britton, Drysand Pinweed, Don Richardson sn, 6 May 1987 (USF)

¤*Lechea lakelae* Wilbur, Lakela's Pinweed, Olga Lakela 30953, 7 Aug 1967 (USF)

Lechea sessiliflora Raf., Pineland Pinweed—27586; scrubland

COMBRETACEAE (3, 4)

Bucida buceras L., Black Olive—28632; boundary between mangrove habitat and ruderal land

Conocarpus erectus L., Buttonwood—29002; mangrove habitat

Conocarpus erectus var. *sericeus* DC., Silver Buttonwood—28799; edge of mangrove habitat

Laguncularia racemosa (L.) C.F. Gaertn., White Mangrove—28832; mangrove habitat

CONVOLVULACEAE (1, 7; *2, 8*)

Ipomoea alba L., Moonflowers—28833; edge of coastal tropical hardwood hammock

Ipomoea indica (Burm.) Merr., Oceanblue Morning-Glory—28463; disturbed, overgrown portion of beach

Ipomoea pes-caprae (L.) R. Br., Railroad Vine—28603; herbaceous zone of coastal strand vegetation

**Ipomoea quamoclit* L., Cypressvine—28867; boundary between forest and ruderal land

Ipomoea sagittata Poir., Saltmarsh Morning-Glory—28953; by shore of Marco Lake

**Ipomoea triloba* L., Littlebell—29120; highly insolated lawn

Ipomoea violacea L., Heavenlyblue Morning-Glory—28870; edge of mangrove habitat

¤*Stylisma abdita* Myint, Showy Dawnflower, Jim Burch 213, 1990; Collier County Natural Resources Division Herbarium

CRASSULACEAE (1, 3)

**Kalanchoe daigremontiana* Raym.-Hamer & H. Perrier, Devil's Backbone—29628; disturbed land

**Kalanchoe delagoensis* Eckl. & Zeyh., Chandelier Plant—29427; disturbed land

Kalanchoe pinnata* (Lam.) Pers., Cathedral Bells—29522; boundary between disturbed scrubland and ruderal land; FLEPPC **II

CUCURBITACEAE (2, 2; *3, 3*)

****Cucumis melo* L., Cantaloupe, Olga Lakela 28539, 1 May, 1965 (USF)**

Melothria pendula L., Creeping Cucumber—28425; by boardwalk through mangrove habitat

**Momordica charantia* L., Balsampear—28743; coastal tropical hardwood hammock

EMPETRACEAE (*1, 1*)

***Ceratiola ericoides* Michx., Florida Rosemary, Olga Lakela 27526; 27 Sep 1964 (USF)**

ERICACEAE (2, 2)

Lyonia fruticosa (Michx.) G.S. Torr., Coastalplain Staggerbush—28077; scrubland

Vaccinium myrsinites Lam., Shiny Blueberry—28954; scrubland

EUPHORBIACEAE (9, 22)

**Acalypha arvensis* Poepp., Threeseed Mercury—29221; disturbed land

Bischofia javanica* Blume, Javanese Bishopwood—28604; by mangrove habitat; FLEPPC **I

Chamaesyce blodgettii (Engelm. ex Hitchc.) Small, Limestone Sandmat—28274; scrubland

Chamaesyce bombensis (Jacq.) Dugand, Dixie Sandmat—28605; herbaceous zone of coastal strand vegetation

¤*Chamaesyce cumulicola* Small, Coastal Dune Sandmat—28192; disturbed land

Chamaesyce hirta (L.) Millsp., Pillpod Sandmat—28669; ruderal land

Chamaesyce hypericifolia (L.) Millsp., Graceful Sandmat—29122; highly insolated lawn

Chamaesyce hyssopifolia (L.) Small, Hyssopleaf Sandmat—28670; lawn

**Chamaesyce lasiocarpa* (Klotzsch) Arthur, Roadside Sandmat—29123; in ditch situated within highly insolated ruderal land

Chamaesyce maculata (L.) Small, Spotted Sandmat—28606; highly insolated gravel

Chamaesyce mesembrianthemifolia (Jacq.) Dugand, Coastal Beach Sandmat—28426; herbaceous zone of coastal strand vegetation

Chamaesyce ophthalmica (Pers.) D.G. Burch, Florida Hammock Sandmat—28532; ruderal land

Chamaesyce prostrata (Aiton) Small, prostrate Sandmat—28699; tree lawn

Cnidoscolus stimulosus (Michx.) Engelm. & A. Gray, Tread Softly—28910; field

¤*Croton glandulosus* var. *floridanus* (A.M. Ferguson) R.W. Long, Vente Conmigo-- 28758; herbaceous zone of coastal strand vegetation

Croton glandulosus var. *glandulosus* L., Vente Conmigo—28294; highly insolated, disturbed land

**Euphorbia graminea* Jacq., Grassleaf Spurge—28607; highly insolated gravel

**Phyllanthus amarus* Schumach. & Thonn., Gale-Of-Wind—28579; disturbed land

**Phyllanthus tenellus* Roxb., Mascarene Island Leafflower—28608; lawn

Poinsettia cyathophora (Murray) Bartl., Paintedleaf—28275; scrubland

Poinsettia heterophylla (L.) Klotzsch & Garcke ex Klotzsch, Fiddler's Spurge—28580; disturbed land

Ricinus communis* L., Castorbean—28834; cleared land; FLEPPC **II

FABACEAE (30, 43; *33, 48*)

Abrus precatorius* L., Rosary Pea—29053; disturbed land; FLEPPC **I

Acacia auriculiformis* A. Cunn. ex Benth., Earleaf Acacia—28295; scrubland; FLEPPC **I

Aeschynomene americana L., Shyleaf—28764; highly insolated, overgrown tree lawn

Aeschynomene viscidula Michx., Sticky Jointvetch—28957; lawn

**Alysicarpus ovalifolius* (Schumach. & Thonn.) J. Leonard, False Moneywort—29092; insolated, cleared land

***Amorpha herbacea* Walter var. *herbacea*, Clusterspike False Indigobush; John K. Small 10487, 1922 (NY)**

Caesalpinia bonduc (L.) Roxb., Gray Nicker—29006; herbaceous zone of coastal strand vegetation

Canavalia rosea (Sw.) DC., Baybean—29054; herbaceous zone of coastal strand vegetation

Centrosema virginianum (L.) Benth., Spurred Butterfly Pea—28328; disturbed land

Chamaecrista fasciculata (Michx.) Greene, Partridge Pea—27693; disturbed land

Chamaecrista nictitans var. *aspera* (Muhl. ex Elliott) H.S. Irwin & Barneby, Sensitive Pea—28533; cleared land

Clitoria mariana L., Atlantic Pigeonwings—28866; edge of scrubland

**Crotalaria incana* L., Shakeshake—27561; disturbed land

**Crotalaria pallida* Aiton, Smooth Rattlebox—28908; disturbed land

****Crotalaria retusa* L., Rattleweed, Olga Lakela 28007 with R.W. Long, F.C. Craighead; 5 Dec 1964 (USF)**

Crotalaria rotundifolia J.F. Gmel., Rabbitbells—28276; scrubland

Dalbergia ecastaphyllum (L.) Taub., Coinvine—28581; edge of natural vegetation

****Delonix regia* (Bojer ex Hook.) Raf., Royal Poinciana, Olga Lakela 28682, 29 May, 1965 (USF)**

Desmanthus virgatus (L.) Willd., Wild Tantan—28700; boundary between mangrove habitat and field

**Desmodium incanum* DC., Zarzabacoa Comun—28277; disturbed land

**Desmodium tortuosum* (Sw.) DC, Dixie Ticktrefoil—28466; disturbed, overgrown portion of beach

**Desmodium triflorum* (L.) DC., Threeflower Ticktrefoil—28836; highly insolated sand

Erythrina herbacea L., Coralbean—27672; coastal tropical hardwood hammock

Galactia elliottii Nutt., Elliott's Milkpea—28909; upland vegetation

Galactia regularis (L.) Britton et al., Eastern Milkpea—28837; scrubland

Galactia striata (Jacq.) Urb., Florida Hammock Milkpea—28872; coastal tropical hardwood hammock

Galactia volubilis (L.) Britton, Downy Milkpea—28873; edge of scrubland

**Indigofera hirsuta* L., Hairy Indigo—28296; highly insolated cleared land

**Indigofera spicata* Forssk., Trailing Indigo—28467; lawn

**Indigofera tinctoria* L., True Indigo—27632; scrubland

***Indigofera trita* L. f. [*Indigofera mucronata* Spreng. ex DC.], Florida Keys Indigo, Alvan W. Chapman s.n., 1800s (NY)**

Leucaena leucocephala* (Lam.) de Wit, White Leadtree—29124; highly insolated, disturbed land; FLEPPC **II

Lupinus diffusus Nutt., Skyblue Lupine—28078; disturbed land

**Macroptilium lathyroides* (L.) Urb., Wild Bushbean—28838; highly insolated tree lawn

**Melilotus albus* Medik., White Sweetclover—28536; highly insolated cleared land

Neptunia pubescens Benth., Tropical Puff—28537; highly insolated lawn

Piscidia piscipula (L.) Sarg., Florida Fishpoison Tree—28593; forest

Pithecellobium unguis-cati (L.) Benth., Catclaw—27882; boundary between coastal tropical hardwood hammock and mangrove habitat

¤*Rhynchosia cinerea* Nash, Brownhair Snoutbean—27587; insolated, disturbed land

Rhynchosia minima (L.) DC., Least Snoutbean—28766; field

**Senna obtusifolia* (L.) H.S. Irwin & Barneby, Coffeeweed—28959; insolated, disturbed land

Sesbania herbacea (Mill.) McVaugh, Danglepod—28703; highly insolated tree lawn

**Sophora tomentosa* var. *occidentalis* (L.) Isely, Necklacepod—27589; scrubland

Sophora tomentosa var. *truncata* Torr. & A. Gray, Necklacepod—29009; landward portion of beach

**Stylosanthes hamata* (L.) Taub., Cheesytoes—28439; tree lawn

****Tamarindus indica* L., Tamarind, Olga Lakela 27763, 23 Oct 1964 (USF)**

Vicia acutifolia Elliott, Fourleaf Vetch—29449; tree lawn

Vigna luteola (Jacq.) Benth., Hairypod Cowpea—28468; disturbed, overgrown portion of beach

FAGACEAE (1, 4)

Quercus chapmanii Sarg., Chapman's Oak—28297; scrubland

Quercus geminata Small, Sand Live Oak—27676; scrubland

Quercus myrtifolia Willd., Myrtle Oak—27677; scrubland

Quercus virginiana Mill., Live Oak—28081; edge of coastal tropical hardwood hammock

GENTIANACEAE (1, 1)

Eustoma exaltatum (L.) Salisb. ex G. Don, Marshgentian—29152; highly insolated, cleared land

GOODENIACEAE (1, 2)

Scaevola plumieri (L.) Vahl, Beachberry—28440; herbaceous zone of coastal strand vegetation

Scaevola taccada* var. *taccada* (Gaertn.) Roxb., Beach Naupaka—28610; woody-plant zone of coastal strand vegetation; FLEPPC **I

HYPERICACEAE (*1, 1*)

***Hypericum tetrapetalum* Lam., Fourpetal St. John's-Wort, Olga Lakela 29521A, 16 Mar 1966 (USF)**

LAMIACEAE (3, 3)

Callicarpa americana L., American Beautyberry—28339; scrubland

**Hyptis pectinata* (L.) Poit., Comb Bushmint—29057; edge of lawn

Trichostema dichotomum L., Forked Bluecurls—28611; woody-plant zone of coastal strand vegetation

LAURACEAE (2, 2)

Cassytha filiformis L., Love Vine—28298; scrubland

Persea borbonia (L.) Spreng., Bay—27636; scrubland

LENTIBULARIACEAE (*1, 1*)

***Utricularia subulata* L., Zigzag Bladderwort, Olga Lakela 30952, 7 Aug 1967 (USF)**

LOASACEAE (1, 1)

Mentzelia floridana Nutt. ex Torr. & A. Gray, Poorman's Patch—28840; field

LOGANIACEAE (1, 1)

Mitreola petiolata (J.F. Gmel.) Torr. & A. Gray, Lax Hornpod—29012; herbaceous zone of coastal strand vegetation

LYTHRACEAE (2, 2)

Ammannia latifolia L., Pink Redstem—29125; in ditch situated within highly insolated ruderal land

Lythrum alatum Pursh, Winged Loosestrife—28538; highly insolated, cleared land

MALVACEAE (6, 8; *7, 9*)

Herissantia crispa (L.) Brizicky, Bladdermallow—27593; Indian Hill (a disturbed dune)

***Kosteletzkya pentacarpos* (L.) Ledeb. [*Kosteletzkya virginica* (L.) C. Presl ex A. Gray], Virginia Saltmarsh Mallow, Olga Lakela 30793 with F. Almeda, 20 Apr 1967 (USF)**

Malvastrum corchorifolium (Desr.) Britton ex Small, False Mallow—29153; disturbed land (grassy area)

Sida acuta Burm. f., Common Wireweed—28301; insolated disturbed land

**Sida cordifolia* L., Llima—29058; edge of lawn

Sida rhombifolia L., Cuban Jute—28707; field

Talipariti tiliaceum* var. *tiliaceum* (L.) Fryxell, Mahoe—28930; natural land; FLEPPC **II

Thespesia populnea* (L.) Sol. ex Correa, Portia Tree—28627; disturbed, overgrown portion of beach; FLEPPC **I

Urena lobata* L., Caesarweed—28539; periphery of pine flatwoods; FLEPPC **II

MELIACEAE (1, 1)

Melia azedarach* L., Chinaberrytree—27892; edge of coastal tropical hardwood hammock; FLEPPC **II

MOLLUGINACEAE (1, 1)

**Mollugo verticillata* L., Indian Chickweed—28769; highly insolated, cleared land

MORACEAE (1, 2; *1, 3*)

Ficus aurea Nutt., Strangler Fig—29209; coastal tropical hardwood hammock

***Ficus elastica* Roxb., Rubber-Plant, H.R. Loconte 954 with J.B. Walker, 12 Mar 1994 (NY)**

Ficus microcarpa L. f., Indian Laurel—29059; disturbed land; FLEPPC **I**

MUNTINGIACEAE (1, 1)

**Muntingia calabura* L., Strawberrytree—29138; oak-*Sabal* hammock

MYRICACEAE (1, 1)

Myrica cerifera L., Southern Bayberry—28278; natural land

MYRSINACEAE (2, 2)

Ardisia escallonioides Schiede & Deppe ex Schltdl. & Cham., Marlberry—27546; coastal tropical hardwood hammock

Rapanea punctata (Lam.) Lundell, Myrsine—27699; coastal tropical hardwood hammock

MYRTACEAE (6, 8)

Eugenia axillaris (Sw.) Willd., White Stopper—27727; coastal tropical hardwood hammock

Eugenia foetida Pers., Spanish Stopper—28915; edge of coastal tropical hardwood hammock

Eugenia uniflora* L., Surinam Cherry—28471; coastal tropical hardwood hammock; FLEPPC **I

Melaleuca quinquenervia* (Cav.) S.T. Blake, Punktree—29096; cleared land by Marco Lake; FLEPPC **I

Myrcianthes fragrans (Sw.) McVaugh, Twinberry—28135; coastal tropical hardwood hammock

Psidium guajava* L., Guava—27894; coastal tropical hardwood hammock; FLEPPC **I

Rhodomyrtus tomentosa* (Aiton) Hassk., Rose Myrtle—28540; pine flatwoods; FLEPPC **I

Syzygium cumini* (L.) Skeels, Java Plum—29157; disturbed land; FLEPPC **I

NYCTAGINACEAE (2, 2)

Boerhavia diffusa L., Red Spiderling—28472; field

Pisonia aculeata L., Devil's Claws—28920; coastal tropical hardwood hammock

OLACACEAE (2, 2)

Schoepfia chrysophylloides (A. Rich.) Planch., Graytwig—27728; coastal tropical hardwood hammock

Ximenia americana L., Tallow Wood—27683; scrubland

OLEACEAE (1, 1)

Forestiera segregata (Jacq.) Krug & Urb., Florida Swamp-privet—27684; disturbed land

ONAGRACEAE (3, 5)

Gaura angustifolia Michx., Southern Beeblossom—28473; disturbed, overgrown portion of beach

Ludwigia octovalvis (Jacq.) Raven, Mexican Primrosewillow—28474; highly insolated, cleared land

Ludwigia peruviana* (L.) H. Hara, Peruvian Primrosewillow—28963; by shore of Marco Lake; FLEPPC **I

Oenothera humifusa Nutt., Seabeach Eveningprimrose—28430; herbaceous zone of coastal strand vegetation

Oenothera laciniata Hill, Cutleaf Eveningprimrose—28844; highly insolated sand

OROBANCHACEAE (2, 2)

Buchnera americana L., American Bluehearts (blue-flowered forma)—29132; in ditch situated within highly insolated ruderal land

Seymeria pectinata Pursh, Piedmont Blacksenna—28480; scrubland

OXALIDACEAE (1, 1)

Oxalis dillenii Jacq., Southern Yellow Woodsorrel—28585; tree lawn

PASSIFLORACEAE (1, 1)

Passiflora suberosa L., Corkystem Passionflower—28541; pine flatwoods

PETIVERIACEAE (3, 3)

Petiveria alliacea L., Guinea Hen Weed—28875; edge of tree island within field

Rivina humilis L., Rougeplant—27729; coastal tropical hardwood hammock

Trichostigma octandrum (L.) H. Walter, Hoopvine—28588; coastal tropical hardwood hammock

PHYTOLACCACEAE (1, 1)

Phytolacca americana L., American Pokeweed—28586; coastal tropical hardwood hammock

PLUMBAGINACEAE (2, 3)

Limonium carolinianum (Walter) Britton, Carolina Sealavender—29215; shaded edge of mangrove habitat

**Plumbago auriculata* Lam., Cape Leadwort—28678; edge of forest

Plumbago scandens L., Doctorbush—27730; edge of coastal tropical hardwood hammock

POLYGALACEAE (1, 1)

Polygala grandiflora Walter, Showy Milkwort—29061; woody plant zone of coastal strand vegetation

POLYGONACEAE (4, 4)

Antigonon leptopus* Hook. & Arn., Coral Vine—28679; disturbed land; FLEPPC **II

Coccoloba uvifera (L.) L., Seagrape—27900; coastal strand vegetation

¤*Polygonella polygama* var. *brachystachya* (Meisn.) Wunderlin, October Flower—28542; scrubland

Polygonum punctatum Elliott, Dotted Smartweed—29127; in ditch situated within highly insolated ruderal land

PORTULACACEAE (1, 2)

Portulaca oleracea L., Little Hogweed—28686; highly insolated, ruderal land

Portulaca pilosa L., Pink Purslane—28543; highly insolated, cleared land

PRIMULACEAE (1, 1)

Samolus ebracteatus Kunth, Water Pimpernel—28544; herbaceous zone of coastal strand vegetation

RHAMNACEAE (1, 1)

Colubrina asiatica* (L.) Brongn., Asian Nakedwood—29013; edge of mangrove habitat; FLEPPC **I

RHIZOPHORACEAE (1, 1)

Rhizophora mangle L., Red Mangrove—28635; by shore of East Marco Bay

ROSACEAE (1, 1)

Prunus caroliniana (Mill.) Aiton, Carolina Laurelcherry—28710; scrubland

RUBIACEAE (13, 17)

Chiococca alba (L.) Hitchc., Snowberry—28966; edge of coastal tropical hardwood hammock

Diodia teres Walter, Poor Joe—28922; edge of scrubland

Diodia virginiana L., Virginia Buttonweed—29128; in ditch situated within highly insolated ruderal land

Ernodea littoralis Sw., Beach Creeper—28442; woody-plant zone of coastal strand vegetation

Galium hispidulum Michx., Coastal Bedstraw—28967; scrubland

Hamelia patens Jacq., Firebush—28878; edge of coastal tropical hardwood hammock

Houstonia procumbens (J.F. Gmel.) Standl, Innocence—29228; junction of lawn and remnant of coastal tropical hardwood hammock

**Mitracarpus hirtus* (L.) DC., Tropical Girdlepod—28879; ruderal land

Morinda royoc L., Redgal—28924; edge of coastal tropical hardwood hammock

**Oldenlandia corymbosa* L., Flattop Mille Graines—28616; highly insolated gravel

Oldenlandia uniflora L., Clustered Mille Graines—28969; highly insolated, disturbed land

Psychotria nervosa Sw., Wild Coffee—27734; coastal tropical hardwood hammock

Randia aculeata L., White Indigoberry—27550; coastal tropical hardwood hammock

**Richardia brasiliensis* Gomes, Tropical Mexican Clover —28618; shaded area within yard

**Richardia grandiflora* (Cham. & Schltdl.) Schult. & Schult. f., Largeflower Mexican Clover—28303; scrubland

Spermacoce assurgens Ruiz & Pav., Woodland False Buttonweed—28881; disturbed land

**Spermacoce verticillata* L., Shrubby False Buttonweed—29130; in ditch situated within highly insolated ruderal land

RUTACEAE (3, 3)

**Citrus x aurantium* L., grapefruit group—29219; natural land;

Murraya paniculata* (L.) Jack, Orange Jessamine—28545; coastal tropical hardwood hammock; FLEPPC **II

Zanthoxylum fagara (L.) Sarg., Wild Lime—28687; woody-plant zone of coastal strand vegetation

SALICACEAE (1, 1)

Salix caroliniana Michx., Carolina Willow—29160; edge of mangrove habitat

SAPINDACEAE (1, 1; *4, 4*)

***Cardiospermum microcarpum* Kunth., Heartseed, Olga Lakela 29241; 6 Oct 1965 (USF)**

**Cupaniopsis anacardioides* (A. Rich.) Radlk., Carrotwood—28475; coastal tropical hardwood hammock; FLEPPC I

***Exothea paniculata* (Juss.) Radlk. ex T. Durand, Inkwood, Olga Lakela 29507, 15 Mar 1966 (USF)**

***Sapindus saponaria* L., Soapberry, Olga Lakela 28514, 1 May 1965 (USF)**

SAPOTACEAE (2, 4)

Chrysophyllum oliviforme L., Satinleaf—27904; coastal tropical hardwood hammock

Sideroxylon celastrinum (Kunth) T.D. Penn., Saffron Plum—28546; oak-*Sabal* hammock

Sideroxylon foetidissimum Jacq., False Mastic—27555; coastal tropical hardwood hammock

Sideroxylon tenax L., Tough Bully—27736; coastal tropical hardwood hammock

SOLANACEAE (4, 5; *4, 6*)

Capsicum annuum L., Bird Pepper—28713; scrubland

Lycium carolinianum Walter, Christmasberry—28443; periphery of mangrove habitat

Physalis angustifolia Nutt., Coastal Groundcherry—29098; periphery of scrubland

Solanum americanum Mill., American Black Nightshade —28433; adjacent to boardwalk through mangrove habitat

***Solanum donianum* Walp., Mullein Nightshade, Olga Lakela 29834, 22 May 1966 (USF)**

**Solanum lycopersicum* L. (= *Lycopersicon esculentum* Mill.), Garden Tomato—29133; edge of food-concession building

STERCULIACEAE (1, 1; *2, 2*)

***Melochia spicata* (L.) Fryxell, Bretonica Peluda, Olga Lakela 27744, 22 Oct 1964 (USF)**

Waltheria indica L., Sleepy Morning—28476; highly insolated, cleared land

SURIANACEAE (1, 1)

Suriana maritima L., Bay Cedar—28444; woody plant zone of coastal strand vegetation

TETRACHONDRACEAE (1, 1)

Polypremum procumbens L., Rustweed—28459; lawn

TURNERACEAE (2, 2)

Piriqueta cistoides (L.) Griseb., Pitted Stripeseed—28547; herbaceous zone of coastal strand vegetation

**Turnera ulmifolia* L., Yellow Alder—28434; disturbed land

URTICACEAE (5, 5)

Boehmeria cylindrica (L.) Sw., False Nettle—28971; by shore of Marco lake

**Laportea aestuans* (L.) Chew, West Indian Woodnettle—29062; disturbed land bordering mangrove habitat

Parietaria floridana Nutt., Florida Pellitory—29135; in shade under building

Pilea microphylla (L.) Liebm., Artillery Plant—28435; by cultivated shrubs

**Pouzolzia zeylanica* (L.) Benn., Pouzolz's Bush—28926; woodland

VERBENACEAE (3, 4)

Lantana camara* L., Lantana—28340; scrubland; FLEPPC **I

Lantana involucrata L., Buttonsage—28781; boundary between the herbaceous zone of, and the woody plant zone of coastal strand vegetation

Phyla nodiflora (L.) Greene, Turkey Tangle Fogfruit—28477; disturbed, overgrown portion of beach

Stachytarpheta urticifolia* Sims, Nettleleaf Velvetberry—29161; insolated, ruderal land; FLEPPC **II

VERONICACEAE (6, 6)

Bacopa monnieri (L.) Pennell, Herb-Of-Grace—29131; in ditch situated within highly insolated ruderal land

Capraria biflora L., Goatweed—29383; boundary between mangrove habitat and tree lawn

**Conobea multifida* (Michx.) Benth., Narrowleaf Paleseed—28882; bare, disturbed land situated by water

**Lindernia crustacea* (L.) F. Muell., Malaysian False Pimpernel—28925; shrub bed

**Russelia equisetiformis* Schltdl. & Cham., Fountainbush—27660; periphery of Indian Hill (a large dune)

Scoparia dulcis L., Sweetbroom—28712; field

VIOLACEAE (*1, 1*)

***Viola primulifolia* L., Primroseleaf Violet, Olga Lakela 29526, 1966 (USF)**

VITACEAE (4, 5)

Ampelopsis arborea (L.) Koehne, Peppervine—28972; boundary between pine flatwoods and ruderal land

Cissus verticillata (L.) Nicolson & C.E. Jarvis, Seasonvine—28549; edge of coastal tropical hardwood hammock

Parthenocissus quinquefolia (L.) Planch., Virginia Creeper—28550; disturbed land

Vitis aestivalis Michx., Summer Grape—28436; scrubland

Vitis rotundifolia Michx., Muscadine—28280; disturbed land

ZYGOPHYLLACEAE (2, 2)

Kallstroemia maxima (L.) Hook. & Arn., Big Caltrop—28619; lawn

Tribulus cistoides* L., Burrnut—28731; overgrown disturbed portion of beach; FLEPPC **II

---

[1] We follow the nomenclature of Wunderlin and Hansen (2003), with the following exceptions. (1) We recognize eight families which they subsumed within other families. Between parentheses, after the name of each family that we recognize is listed the corresponding family in Wunderlin and Hansen (2003): Aceraceae (Sapindaceae), Asclepiadaceae (Apocynaceae), Capparaceae (Brassicaceae), Chenopodiaceae (Amaranthaceae), Empetraceae (Ericaceae), Hypericaceae (Clusiaceae), Lygodiaceae (Schizaeaceae), and Sterculiaceae (Malvaceae). (2) We include Flaveria floridana J.R. Johnst. within Flaveria linearis Lag., as did Cronquist (1980). (3) We recognize Oxalis dillenii Jacq. and Urochloa subquadripara (Trin.) R. D. Webster, as did Weishaupt (1971) and Wipff and Thompson (2003), respectively. Wunderlin and Hansen (2003) subsumed these species into Oxalis corniculata L. and Urochloa distachya (L.) T. Q. Nguyen, respectively. (4) We recognize varieties of Conocarpus erectus L., Digitaria ciliaris (Retz.) Koeler, and Paspalum setaceum Michx., as did Long and Lakela (1976), Wipff (2003), and Allen and Hall (2003), respectively. Wunderlin and Hansen (2003) did not do so. (5) We recognize Digitaria filiformis var. villosa (Walter) Fernald, as did Wipff (2003) but not Wunderlin and Hansen (2003). (6) We apply the name Ruellia brittoniana Leonard to the species that Wunderlin and Hansen called Ruellia tweediana Griseb. (7) Persea borbonia was problematical on Marco Island. Wunderlin and Hansen (2003), Long and Lakela (1976), and Wofford and Pearman (1975) distinguished between Persea borbonia var. borbonia (Red Bay) and Persea borbonia var. humilus (Scrub Bay) (or between taxa synonymous with these varieties), based on differences in abaxial pubescence of the foliage leaves. Our collections exhibited a spectrum of pubescences that were sometimes intermediate and not readily matching either variety. Thus, we do not recognize varieties of P. borbonia.

[2] Ms. Martha McCombs contributed importantly to SWF; hence, on the label of each herbarium sheet from SWF George Wilder's name and Martha McCombs' name precede the collection number of each specimen, a circumstance not duplicated in this Appendix.

[3] Data for previous collections were compiled from Virtual Herbarium (2008), New York Botanical Garden (2008), Gann et al. (2002), Wunderlin and Hansen (2008), and Mr. John Kunzer of USF (pers. comm., 1 Dec 2008). Gann et al. (2002) concluded that three species were apparently collected on Marco Island: Indigofera trita, Juncus repens, and Solidago tortifolia. Gann et al. (2002) listed the years or the range of years of collection, but not precise collection dates.

APPENDIX II

Tabulation of inventories compiled during this study, of native taxa growing in selected site(s) within each of the six main kinds of natural habitats remaining on Marco Island. An **X** signifies the presence of a taxon within a kind of habitats when all selected site(s) of that kind are represented, collectively (each of HZ, WZ, MANG, PF). A fraction also signifies the occurrence of a taxon in a kind of habitats (each of CTHH, SCR); the numerator indicates the number of selected sites exhibiting that taxon, the denominator signifies the total number of selected sites investigated (7 sites from CTHH; 6 sites from SCR). *Asimina* sp., *Ficus* sp., *Galactia* sp., *Mikania* sp., *Rhynchosia* sp., and *Smilax* sp. represent individuals not identifiable to species, because of sterility or based on other deficiencies; these individuals might belong to other taxa listed separately, herein. **HZ** = herbaceous zone of coastal strand vegetation; **WZ** = woody-plant zone of coastal strand vegetation; **MANG** = mangrove habitat; **CTHH** = coastal tropical hardwood hammock; **PF** = pine flatwoods; **SCR** = scrubland.

TAXON	HZ	WZ	MANG	CTHH	PF	SCR
Acer rubrum					X	
Acrostichum aureum			X			
Acrostichum danaeifolium			X	1/7		
Alternanthera flavescens	X	X	X			1/6
Ambrosia artemisiifolia	X	X				
Ampelopsis arborea					X	
Andropogon glomeratus	X	X				1/6
Andropogon ternarius						1/6

TAXON	HZ	WZ	MANG	CTHH	PF	SCR
Andropogon virginicus	X	X				1/6
Ardisia escallonioides				4/7		1/6
Aristida condensata						1/6
Aristida patula	X					
Aristida purpurascens	X					3/6
Asimina sp.						2/6
Atriplex cristata	X					
Avicennia germinans	X		X			
Baccharis glomeruliflora					X	
Baccharis halimifolia		X	X	1/7		
Bacopa monnieri			X			
Batis maritima			X			
Bidens alba	X	X				2/6
Blechnum serrulatum			X	2/7	X	
Blutaparon vermiculare	X		X			
Borrichia frutescens			X			
Buchnera americana	X					
Bulbostylis ciliatifolia						6/6
Bulbostylis stenophylla						2/6
Bursera simaruba	X	X		7/7	X	4/6
Caesalpinea bonduc	X	X	X	1/7		
Callicarpa americana				7/7	X	5/6
Canavalia rosea	X	X				
Cassytha filiformis					X	6/6
Cenchrus spinifex	X	X				6/6
Centrosema virginianum	X					2/6
Chamaecrista fasciculata	X	X				6/6
Chamaecrista nictitans var. *aspera*	X					
Chamaesyce blodgettii	X					
Chamaesyce bombensis	X					
Chamaesyce cumulicola						4/6
Chamaesyce mesembrianthemifolia	X					
Chiococca alba		X	X	5/7		
Chrysobalanus icaco	X	X	X	6/7	X	3/6
Chrysophyllum oliviforme				5/7	X	
Chrysopsis scabrella						1/6
Cissus verticillata			X	1/7	X	
Cladium jamaicense					X	
Coccoloba uvifera	X	X	X	4/7		1/6
Commelina erecta	X	X				1/6
Conocarpus erectus		X	X			
Conocarpus erectus var. *sericeus*			X			
Conyza canadensis	X					1/6
Coreopsis leavenworthii	X					
Crinum americanum				4/7		
Crotalaria rotundifolia	X					
Croton glandulosus var. *floridanus*	X	X				3/6
Croton glandulosus var. *glandulosus*	X					
Cynanchum angustifolium	X					
Cyperus croceus						1/6
Cyperus ligularis	X	X		1/7		1/6
Cyperus polystachyos	X					
Cyperus retrorsus	X	X				6/6
Cyperus tetragonus				1/7		
Dalbergia ecastaphyllum	X	X	X	3/7		

TAXON	HZ	WZ	MANG	CTHH	PF	SCR
Dichanthelium aciculare						3/6
Digitaria filiformis	X	X				
Distichlis spicata			X			
Encyclia tampensis				5/7		
Eragrostis elliottii	X	X				
Ernodea littoralis	X	X				
Erythrina herbacea				4/7		1/6
Eugenia axillaris				6/7		
Eugenia foetida				3/7		
Eupatorium serotinum			X			
Eustachys petraea	X	X				2/6
Ficus aurea			X	5/7		
Ficus sp.		X		2/7	X	1/6
Fimbristylis caroliniana	X	X				
Fimbristylis cymosa	X	X	X			1/6
Fimbristylis spadicea	X		X			
Flaveria linearis	X	X				
Forestiera segregata		X		1/7		
Gaillardia pulchella	X					
Galactia elliottii					X	1/6
Galactia regularis						1/6
Galactia sp.						3/6
Galactia striata				1/7		
Galactia volubilis	X	X				
Galium hispidulum				1/7	X	2/6
Gaura angustifolia	X	X				
Helianthus debilis subsp. *debilis*	X	X				
Heliotropium polyphyllum	X	X				
Heterotheca subaxillaris	X	X				4/6
Hippocratea volubilis				1/7		
Hymenocallis latifolia	X	X				
Ipomoea alba	X		X			
Ipomoea indica	X	X	X			
Ipomoea pes-caprae	X					
Ipomoea violacea			X			
Iresine diffusa	X	X		2/7		2/6
Iva imbricata	X	X				
Laguncularia racemosa	X		X			
Lantana involucrata		X		1/7		
Liatris tenuifolia						1/6
Licania michauxii						5/6
Lipocarpha micrantha	X	X				
Lycium carolinianum			X			
Lyonia fruticosa						4/6
Melothria pendula			X			
Mikania scandens			X			
Mikania sp.					X	
Mitreola petiolata	X					
Morinda royoc				2/7		
Muhlenbergia capillaris var. *filipes*	X	X				
Myrcianthes fragrans		X		4/7		
Myrica cerifera		X		2/7		1/6
Nephrolepis exaltata				1/7		
Oenothera humifusa	X					
Oplismenus hirtellus				3/7		

TAXON	HZ	WZ	MANG	CTHH	PF	SCR
Opuntia humifusa	X	X				6/6
Osmunda regalis					X	
Palafoxia feayi						6/6
Panicum amarum	X					
Paronychia americana						1/6
Parthenocissus quinquefolia	X	X	X	5/7		2/6
Paspalum setaceum var. *ciliatifolium*	X					
Paspalum setaceum var. *rigidifolium*						2/6
Paspalum setaceum var. *stramineum*		X				1/6
Paspalum setaceum var. *villosissimum*						1/6
Paspalum vaginatum	X					
Passiflora suberosa				3/7	X	
Pentalinon luteum		X				
Persea borbonia				6/7		5/6
Phlebodium aureum				5/7	X	
Phyla nodiflora	X					
Physalis angustifolia	X	X				2/6
Phytolacca americana				2/7		
Pinus elliottii					X	1/6
Piriqueta cistoides	X					
Piscidia piscipula	X	X	X	6/7		
Pithecellobium unguis-cati				4/7		
Pityopsis graminifolia						1/6
Pleopeltis polypodioides				5/7		
Pluchea odorata			X			
Plumbago scandens				2/7		1/6
Poinsettia cyathophora	X	X				2/6
Polanisia tenuifolia						5/6
Polygala grandiflora	X	X				
Polygonella polygama var. *brachystachya*						4/6
Polypremum procumbens	X	X				
Prunus caroliniana						1/6
Psilotum nudum				3/7		
Psychotria nervosa				7/7	X	4/6
Pteridium aquilinum var. *caudatum*				1/7		
Pteridium aquilinum var. *pseudocaudatum*				2/7	X	
Quercus chapmanii				1/7		3/6
Quercus geminata						6/6
Quercus myrtifolia						6/6
Quercus virginiana		X		6/7	X	2/6
Randia aculeata		X	X	7/7		
Rapanea punctata		X	X	7/7	X	2/6
Rhabdadenia biflora			X	3/7		
Rhizophora mangle	X		X			
Rhus copallinum		X		1/7		6/6
Rhynchosia cinerea	X					
Rhynchosia sp.						1/6
Rhynchospora colorata	X					
Rhynchospora megalocarpa						1/6
Rivina humilis				5/7		2/6
Sabal palmetto	X	X	X	7/7	X	1/6
Salix caroliniana					X	
Samolus ebracteatus	X	X				
Sarcocornia perennis			X			
Sarcostemma clausum			X		X	

TAXON	HZ	WZ	MANG	CTHH	PF	SCR
Scaevola plumieri	X	X				
Schoepfia chrysophylloides				5/7		
Scleria ciliata var. *curtissii*						1/6
Scleria triglomerata						3/6
Serenoa repens	X			5/7	X	6/6
Sesuvium portulacastrum	X		X			
Setaria corrugata						3/6
Seymeria pectinata						1/6
Sida acuta		X				1/6
Sideroxylon celastrinum	X	X	X	5/7		
Sideroxylon foetidissimum				5/7		
Sideroxylon tenax				1/7		5/6
Smilax auriculata	X	X			X	5/6
Smilax bona-nox				1/7		
Smilax sp.				4/7		1/6
Solanum americanum			X			
Solidago odora						2/6
Solidago sempervirens	X	X	X			
Sophora tomentosa var. *truncata*	X	X				
Sorghastrum secundum						1/6
Spartina patens	X					
Spermacoce assurgens		X				
Sporobolus domingensis	X		X			
Sporobolus virginicus	X					
Stipulicida setacea var. *lacerata*						1/6
Suaeda linearis	X		X			
Suriana maritima	X	X				
Tillandsia balbisiana				4/7		
Tillandsia fasciculata		X	X	5/7		3/6
Tillandsia flexuosa			X	1/7		3/6
Tillandsia paucifolia			X	1/7		1/6
Tillandsia recurvata			X	4/7		5/6
Tillandsia setacea			X	6/7		
Tillandsia usneoides		X	X	5/7		4/6
Tillandsia utriculata			X	3/7		3/6
Tournefortia volubilis				1/7		
Toxicodendron radicans	X	X	X	7/7	X	1/6
Trichostema dichotomum	X	X				
Trichostigma octandrum				1/7		
Triplasis americana						1/6
Triplasis purpurea	X					1/6
Uniola paniculata	X	X				
Vaccinium myrsinites						1/6
Verbesina virginica	X					
Vigna luteola	X	X				
Vitis aestivalis				3/7		1/6
Vitis rotundifolia		X	X	7/7	X	6/6
Vittaria lineata				4/7		
Waltheria indica	X	X				
Woodwardia virginica					X	
Ximenia americana				3/7		5/6
Yucca aloifolia	X	X		1/7	X	
Zanthoxylum fagara				4/7		

DEDICATION AND ACKNOWLEDGMENTS

We dedicate this paper to environmentally concerned citizens of Marco Island, with the hope that it will foster increased appreciation and understanding of their botanical heritage.

We express deep appreciation to Brian Holley and the Naples Botanical Garden for providing laboratory space for the present study and for housing the Herbarium of Southwestern Florida. We are grateful to Kate Kintz, a graphic designer who modified Figs. 1 and 2. We also thank the following individuals and institutions for their assistance: Brian Bovard; Chris Brighton; Ronald Echols; Susan Gallagher; Bruce Hansen, John Kunzer, Richard Wunderlin, and the Institute for Systematic Botany (University of South Florida); Melissa Hennig; Brandon Jones; Jeannette Kling; John Mickel; William Marquardt; Jacob Mitchell; Elizabeth Perdichizzi and the Marco Island Historical Society; Nancy Richie, Julie Ross, and the City of Marco Island; Pamela Riggs; Tom Ryan and Hideaway Beach Golf Club; Eva Schliesser; Brenda Thomas; Gerry Tsandoulas, Marie Tsandoulas, and the Key Marco Community Association; Douglas Waitley; Laura Wewerka; Joseph Wipff; and Lynka Woodbury.

REFERENCES

Allen, C.M. and D.W. Hall. 2003. *Paspalum* L. In: Flora of North Editorial Committee, ed., Flora of North America north of Mexico. Vol. 25. Oxford University Press, NY.

Austin, D.F. 1987. The Florida of John Kunkel Small: his species and types, collecting localities, bibliography and selected reprinted works. Contrib. New York Bot. Gard. 18:1–207.

Austin, D.F. 2004. Florida ethnobotany. CRC Press, Boca Raton, FL.

Beriault, J.G. 1980. The natural features and prehistory of Marco Island, Florida. In: P.J. Gleason, ed., Water, oil, and the geology of Collier, Lee and Hendry counties. Miami Geological Society, Miami, FL.

Bradley, K.A. 1999. Observations of vascular plants at Tiger Tail Beach, Collier County, Florida, 04/29/1999. In: G.D. Gann, K.A. Bradley, and S.W. Woodmansee. 2001–2008, The Floristic Inventory of South Florida Database Online. http://regionalconservation.org/ircs/database/plants/. The Institute for Regional Conservation, Miami, FL.

Chapman, A.W. 1878. An enumeration of some plants – chiefly from the semi-tropical regions of Florida - which are either new, or which have not hitherto been recorded as belonging to the flora of the southern states. Bot. Gaz. 3:2–6, 9–12, 17–21.

Collier County Facilities Management Department. 2007. Otter Mound Preserve. 3rd Draft. Land Management Plan. Unpublished.

Cronquist, A. 1980. Vascular flora of the Southeastern United States. Vol. I. Asteraceae. The University of North Carolina Press, Chapel Hill.

Florida Exotic Pest Plant Council. 2008. Florida EPPC's 2007 invasive plant species list.http://www.fleppc.org/list/07list.htm.Center for invasive species and ecosystem health, University of Georgia, Tifton.

Florida Natural Areas Inventory and Florida Department of Natural Resources. 1990. Guide to the natural communities of Florida. Florida Natural Areas Inventory, Tallahassee.

Florida Natural Areas Inventory. 2008. FNAI tracking list.http://www.fnai.org/bioticssearch.cfm. Florida Natural Areas Inventory, Tallahassee.

Gann, G.D., K.A. Bradley, and S.W. Woodmansee. 2002. Rare plants of South Florida: their history, conservation, and restoration. The Institute for Regional Conservation, Miami, FL.

Gilliland, M.S. 1989. The material culture of Key Marco Florida. Florida Classics Library, Port Salerno.

Gilliland, M.S. 1989a. Key Marco's buried treasure. Archaeology and adventure in the nineteenth century. University of Florida Press, Gainesville.

Johnson, A.F. and M.G. Barbour. 1990. Dunes and maritime forests. In: R.L Myers and J.J. Ewel, eds. Ecosystems of Florida. University of Central Florida Press, Orlando.

Johnson, A.F. and J.W. Muller. 1993. An assessment of Florida's remaining coastal upland natural communities: southwest Florida. Florida Natural Areas Inventory, Tallahassee.

Liudahl, K. et al. 1998. Soil survey of Collier County area, Florida. U.S. Dept. Agriculture Natural Resources Conservation Service.

Long, R.W. and O. Lakela. 1976. A flora of tropical Florida. A manual of the seed plants and ferns of southern peninsular Florida. Banyan Books, Miami, FL.

Milanich, J.T. 1994. Archaeology of precolumbian Florida. Univ. Press of Florida, Gainesville.

Natural Areas Management Co. no date. Marco Nature Park. Unpublished.

Perdichizzi, E.M. and K.S. Kirk. 2006. Island voices. They came to Marco Island. Caxambas Publishing, Marco Island, FL.

Small, J.K. 1922. The botanical fountain of youth. J. New York Bot. Gard. 23:117–133; 139–155. Reprinted in: D.F. Austin. 1987. The Florida of John Kunkel Small: his species and types, collecting localities, bibliography and selected reprinted works. Contr. New York Bot. Gard. 18:1–207.

Small, J.K. 1923. Green deserts and dead gardens. J. New York Bot. Gard. 24:193–247.

Small, J.K. 1929. From Eden to Sahara. Florida's tragedy. The Science Press, Lancaster, PA.

Tebeau, C.W. 1966. Florida's last frontier. The history of Collier County. University of Miami Press, Miami.

The Marco Island Eagle. Mar 14, 1984. Nature park to be dedicated here Friday. Section A, p. 6.

The New York Botanical Garden. 2008. The virtual herbarium of the New York Botanical Garden.http://www.nybg.org/bsci/vh/ New York Botanic Garden, NY.

Tsandoulas, G. and E. Ward. 2008. Key Marco vegetation management plan. Unpublished.

Virtual Herbarium. 2008. Virtual Herbarium.http://www.virtualherbarium.org/ Fairchild Tropical Botanic Garden, Coral Gables, FL.

Waitley, D. 1999. The last paradise. The building of Marco Island. The Marco Island Eagle, Marco Island, FL.

Weishaupt, C.G. 1971. Vascular plants of Ohio, 3d ed. Kendall/Hunt Publ. Co., Dubuque, IA.

Wilder, G.J. and M.R. McCombs. 2006. New and significant records of vascular plants for Florida and for Collier County and Lee County, Florida. Sida 22:787–799.

WIPFF, J.K. 2003. *Digitaria* Haller. In: Flora of North America Editorial Committee, ed., Flora of North America north of Mexico. Vol. 25. Oxford University Press, NY.

Wipff, J.K. and R.A. Thompson. 2003. *Urochloa* P. Beauv. In: Flora of North America Editorial Committee, ed., Flora of North America north of Mexico. Vol. 25. Oxford University Press, NY.

Wofford, B.E. and R.W. Pearman. 1975. An SEM study of leaf surface pubescence in the southeastern taxa of *Persea*. Sida. 6:19–23.

Wunderlin, R.P. and B.F. Hansen. 2003. Guide to the vascular plants of Florida, 2nd ed. University Press of Florida, Gainesville.

Wunderlin, R.P. and B.F. Hansen. 2008. Atlas of Florida vascular plants.http://www.plantatlas.usf.edu/isb/.Institute for Systematic Botany, University of South Florida, Tampa.

BOOK NOTICE

Neal K. Van Alfen, George Bruening, and Jan E. Leach (eds). 2009. **Annual Review of Phytopathology, Volume 47.** (ISSN 0066-4286; ISBN 978-0-8243-1347-0, hbk). Annual Reviews, Inc., 4139 El Camino Way, P.O. Box 10139, Palo Alto, California 94303-0139, U.S.A. (**Orders:** www.AnnualReviews.org, science@annualreviews.org, 1-800-523-8635, 1-650-493-4400). $84.00 indiv., 445 pp., 7 5/8" × 9 3/8".

Contents of Volume 47:

1. Look Before You Leap: Memoirs of a "Cell Biological" Plant Pathologist—*Michèle C. Heath*
2. Plant Disease Diagnostic Capabilities and Networks—*Sally A. Miller, Fen D. Beed, & Carrie Lapaire Harmon*
3. Diversity, Pathogenicity, and Management of Verticillium Species—*Steven J. Klosterman, Zahi K. Atallah, Gary E. Vallad, & Krishna V. Subbarao*
4. Bacterial/Fungal Interactions: From Pathogens to Mutualistic Endosymbionts—*Donald Y. Kobayashi & Jo Anne Crouch*
5. Community Ecology of Fungal Pathogens Causing Wheat Head Blight—*Xiangming Xu & Paul Nicholson*
6. The Biology of Viroid-Host Interactions—*Biao Ding*
7. Recent Evolution of Bacterial Pathogens: The Gall-Forming *Pantoea agglomerans* Case—*Isaac Barash & Shulamit Manulis-Sasson*
8. Fatty Acid-Derived Signals in Plant Defense—*Aardra Kachroo & Pradeep Kachroo*
9. Salicylic Acid, a Multifaceted Hormone to Combat Disease—*A. Corina Vlot, D'Maris Amick Dempsey, & Daniel F. Klessig*
10. RNAi and Functional Genomics in Plant Parasitic Nematodes—*M.N. Rosso, J.T. Jones, & P. Abad*
11. Fungal Effector Proteins—*Ioannis Stergiopoulos & Pierre J.G.M. de Wit*
12. Durability of Resistance in Tomato and Pepper to Xanthomonads Causing Bacterial Spot—*Robert E. Stall, Jeffrey B. Jones, & Gerald V. Minsavage*
13. Seed Pathology Progress in Academia and Industry—*Gary P. Munkvold*
14. Migratory Plant Endoparasitic Nematodes: A Group Rich in Contrasts and Divergence—*Maurice Moens & Roland N. Perry*
15. The Genomes of Root-Knot Nematodes—*David McK. Bird, Valerie M. Williamson, Pierre Abad, James McCarter, Etienne G.J. Danchin, Philippe Castagnone-Sereno, & Charles H. Opperman*
16. Viruses of Plant Pathogenic Fungi—*Said A. Ghabrial & Nobuhiro Suzuki*
17. Hordeivirus Replication, Movement, and Pathogenesis—*Andrew O. Jackson, Hyoun-Sub Lim, Jennifer Bragg, Uma Ganesan, & Mi Yeon Lee*
18. *Ustilago maydis* as a Pathogen—*Thomas Brefort, Gunther Doehlemann, Artemio Mendoza-Mendoza, Stefanie Reissmann, Armin Djamei, & Regine Kahmann*

J. Bot. Res. Inst. Texas 3(2): 900. 2009

THYMELAEA PASSERINA (THYMELAEACEAE) IN SOUTH DAKOTA

Grace Kostel

Black Hills State University
1200 University Street, Unit 9003
Herbarium, J159
Spearfish, South Dakota 57799-9003, U.S.A.
GraceKostel@bhsu.edu

ABSTRACT

Thymelaea passerina (L.) Cosson & J. Germain (Thymelaeaceae) is reported as an addition to the flora of South Dakota. A description of the species and information for vouchered specimens are provided.

KEY WORDS: *Thymelaea passerina*, Thymelaeaceae, naturalized, Conata Basin, South Dakota, invasive species

RESUMEN

Thymelaea passerina (L.) Cosson & J. Germain (Thymelaeaceae) se presenta como adición a la flora de Dakota del Sur. Se describe la especie y se incluye información sobre los especímenes documentados.

INTRODUCTION

In the summer of 2008, the author discovered a population of *Thymelaea passerina* (common name, spurge flax), a species thought to be unknown from the state, to be well established on a disturbed site in Conata Basin, Pennington County, South Dakota. The population of ca. 1000 individual plants scattered throughout several acres of Conata Basin clearly indicates a potential for naturalization. Although no published record of *T. passerina* in South Dakota exists, a later search through herbarium records revealed a collection made in 1989 by Craig Freeman and Ralph E. Brooks in Tripp County. A formal description of the species and new information about its known distribution in the state follow.

Original voucher specimen: **U.S.A. SOUTH DAKOTA. Tripp Co.:** T97S R76E S4 NW ¼, 7 mi W of Colome, level to slightly rolling subirrigated sand prairie, plants common along fence line at N end of prairie next to road, 11 Jul 1989, *R.E. Brooks 19582 & C. Freeman* (KANU, KS, U.S. 298531).

Recent voucher specimen: **U.S.A. SOUTH DAKOTA. Pennington Co.:** T3S R16E S23. 43.7707000 N; -102.1685000 W (Datum = NAD83), Buffalo Gap National Grassland, Conata Basin, ca. 14 mi due S of Wall and 0.5–1 mi E of Conata Basin Road, elev. 2570 ft, prairie dog town, soils are deep clay overlain with gravel and cobble, area evidences recent revegetation/recovery from drought and heavy use, ca. 1000 plants scattered over several acres, 4 Sep 2008, *Grace M. Kostel 12666* (BHSC, SD, U.S. 41571).

MORPHOLOGY

Thymelaea passerina is a taprooted herbaceous annual to 55–60 cm tall and characteristically slender, wiry and erect. Spurge flax grows as one main stem or, more commonly, branches from the upper portion of the main stem. Leaves are alternate and sessile, leathery, and jointed at a yellow cartilaginous base; blades are small, narrow and linear, 8–14 mm long, progressively smaller upward along the stems. The flowers are perfect, greenish, tubular and axillary, 2–3 mm long, with 4 sepals, no petals, and 8 stamens (in 2 whorls of 4). Below each flower, two very small bracts arise from a tuft of tiny white hairs. The fruit is one-seeded, the enclosed seed round, brown to black and 2–3 mm long (McGregor 1986; Kaul et al. 2006).

DISCUSSION

Thymelaea passerina was first reported in the United States by Pohl in 1955. *Thymelaea passerina* is native to Northern Africa, Europe and Asia where it is considered a common weed of dry soils and grain fields (Pohl

J. Bot. Res. Inst. Texas 3(2): 901 – 903. 2009

1955; Wofford & De Selm 1988). It is also found in central Russia, Australia and North America. In the U.S., it is recorded from Iowa and Nebraska (Pohl 1955), Illinois (Mohlenbrock & Ladd 1978), Wisconsin (Harriman 1979), Kansas (McGregor 1986), Ohio (Vincent & Thieret 1987), Mississippi (Wofford & De Selm 1988), Alabama (Webb et al. 1997), and Texas (Holmes et al. 2000). In Washington state *T. passerina* was identified in 1996 in Okanogan County and was subsequently listed as a Class A noxious weed (USDA NRCS 1999).

Introduction to Tripp County may have been facilitated through agricultural activity associated with grazing and feeding cattle, e.g., introduced as seed in hay. We can only speculate as to how *T. passerina* may have been introduced to Conata Basin. Several years of activity associated with the recreational killing of prairie dogs (*Cynomys ludoviciana*) and the actions associated with the reintroduction of black footed ferrets (*Mustela nigripes*) by the U.S. Fish and Wildlife Service (USFWS) and U.S. Forest Service (USFS) in Conata Basin may have played a role. Knowledge of how long an introduced species has been established in a region is important. Assessments of a species' invasiveness can be made too soon, for example, thus increasing the likelihood of labeling a potentially invasive species in its lag phase as "safe." Such mistakes are common (IUCN 2002). Lag phases of up to 180 years have been found for herbaceous species (Pyšek & Prach 1993). In Washington State, Class A plants, such as *T. passerina*, are required by law to be given highest priority. Such effort is consistent with the state's purpose that nonnative species whose distribution is still limited are best dealt with by preventing new infestations and eradicating existing ones as soon as possible.

Thymelaea passerina can be difficult to identify. In the field, the plant closely resembles some *Polygonum* species but upon close examination, no ocrea (a papery sheath) is found at the leaf nodes. Spurge flax is the only species in *Thymelaea* and the only herbaceous annual Thymelaeaceae, thus it is absent from many taxonomic keys. Officials in Washington have observed that animals will not graze this plant. Alkaline rangeland and disturbed places are typical of sites where *T. passerina* has been found (USDA NRCS 1999), and such habitats are common to the complex and highly altered Conata Basin ecosystem. Spurge flax is reported to be difficult to control by herbicides due to the lack of surface area of the small, leathery leaves. A KANU specimen label for *T. passerina* (*KANU 298425*, and many duplicates at NEB, collected in 1950) allude to its weediness by indicating the plant had "almost completely taken over a pasture" in the northern part of Cedar County, Nebraska.

CONCLUSION

Thymelaea passerina is clearly established in South Dakota and has the potential for wider naturalization. The 1989 collection introduced a new family, Thymelaeaceae, to the flora of the state. *Thymelaea passerina*, or spurge flax, has proven to be aggressive and difficult to control in other regions. Livestock do not graze the plant, and at Conata Basin, none of the *ca.* 1000 plants observed were noted to have been grazed by prairie dogs. An assertive control program at Conata Basin makes management, and possibly eradication, of spurge flax feasible at this time. Given the relatively isolated geology of Conata Basin, it may be possible to contain the alien and prevent it from spreading. In addition, monitoring by the USFS of the Conata Basin flora would greatly aid in identifying new invasions. A return to the site of the initial 1989 find in Tripp County could also provide valuable information about its persistence and invasive pattern.

ACKNOWLEDGMENTS

Biodiversity occurrence data provided by: University of Kansas Natural History Museum, R.L. McGregor Herbarium (KANU) accessed through the efforts of Steve Rolfsmeier and Caleb Morse. Sincere appreciation is extended to Raul Gutierrez, Robert Kaul, Gary E. Larson and Steve Rolfsmeier for review of the manuscript. Appreciation is extended to Craig Freeman for verifying the data of his initial collection in South Dakota in 1989 with Ralph Brooks. The author is grateful for the work of M.L. Gabel and Peggy Buckwalter on the Spanish translation.

REFERENCES

Great Plains Flora Association. 1986. Flora of the Great Plains. University Press of Kansas, Lawrence.

Harriman, N.A. 1979. Four additions to the Wisconsin flora. Michigan Bot. 18:143–145.

Holmes, W.C., J.F. Pruski, and J.R. Singhurst. 2000. *Thymelaea passerina* (Thymelaeaceae) new to Texas. Sida 19:403–406.

IUCN. 2002. Turning the tide: the eradication of invasive species. Veitch, C.R. and M.N. Cloud, eds. Occasional Paper of the IUCN Species Survival Commission No. 27. Available at: http://www.hear.org/articles/turningthetide/turningthetide.pdf.

Kaul, R.B., D.M. Sutherland, and S.B. Rolfsmeier. 2006. The flora of Nebraska. University of Nebraska, Lincoln.

McGregor, R.L. 1986. Thymelaeaceae. In: Flora of the Great Plains University Press of Kansas, Lawrence. P. 498.

Mohlenbrock, R.H. and D.M. Ladd. 1978. Distribution of Illinois vascular plants. Southern Illinois University Press, Carbondale.

Pohl, R.W. 1955. *Thymelaea passerina*, a new weed in the United States. Iowa Acad. Sci. 62:152–154.

Pyšek, P. and K. Prach. 1993. Plant invasions and the role of riparian habitats – a comparison of four species alien to central Europe. J. Biogeogr. 20:413–420.

USDA, NRCS. 1999. The PLANTS database (http://plants.ussda.gov/plants) accessed 4/19/2009. National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

Vincent, M.A. and J.W. Thieret. 1987. *Thymelaea passerina* (Thymelaeaceae) in Ohio. Sida 12:75–78.

Webb, D.H., H.R. DeSelm, and W.M. Dennis. 1997. Studies of prairie barrens of northwestern Alabama. Castanea 62:173–184.

Wofford, B.E. and H.R. De Selm. 1988. Distribution of and first report of *Thymelaea passerina* from the southeastern United States. Castanea 53:305–306.

BOOK NOTICE

F.O. Zuloaga, O. Morrone, and M.J. Belgrano (eds). 2008. **Catálogo de las Plantas Vasculares del Cono Sur: Argentina, Sur de Brasil, Chile, Paraguay y Uruguay - Volumen 1, 2, and 3.** (ISBN 978-1-930723-70-2, hbk.). Missouri Botanical Garden Press, 4344 Shaw Boulevard, St. Louis, Missouri 63110-2291, U.S.A. (**Orders:** www.mbgpress.org, mbgpress@mobot.org, 1-314-577-9534, 1-314-577-9594 fax). $375.00 set, Vol. 1: 984 pp., Vol. 2: 1302 pp., Vol. 3: 1602 pp., 8 1/2" × 11 1/4".

Vol. 1. Pteridophyta, Gymnospermae, Monocotyledoneae
Vol. 2. Dicotyledoneae: Acanthaceae–Fabaceae (*Abarema–Schizolobium*)
Vol. 3. Dicotyledoneae: Fabaceae (*Senna–Zygia*)–Zygophyllaceae

The three volumes of the *Catálogo* present a critical list of the species and taxa that grow in the subtropical and temperate to cold-temperate areas of South America, the Cono Sur or Southern Cone, which includes more than 4,700,000 square kilometers. The Introduction (in both Spanish and English) presents a short description of the biogeographical regions in the area.

A total of 17,697 accepted species are treated, about the same number that occur in the United States, a much larger region. More than 42,000 synonyms are indicated, as well as other taxa excluded from the study area, and dubious citations and names. At least one voucher supports each of the accepted names. The catalogue is organized alphabetically by family, genera, and species and documented with bibliographic citations, herbarium specimens, and information on their distribution, habit, native or introduced status, elevation, and cross-reference synonymy.

From the publisher: "The comprehensive catalogue is a taxonomic landmark, without modern, published precedence; it's the first time that such an international list has been assembled … . Scientists will now have a guide for applying the currently accepted names when identifying a plant for scientific investigation. Because the *Catalogue* lists the geographic locations for all 17,697 plants, scientists can use it as a guide to monitor the changes in the distribution of individual plant species that will occur as a result of habitat destruction, overharvesting, or global warming."

ANNOTATED LIST OF MARYLAND GRASSES (POACEAE)

Edward E. Terrell and Paul M. Peterson

Department of Botany
National Museum of Natural History
Smithsonian Institution
Washington, D.C. 20013-7012, U.S.A.
terr60@msn.com; peterson@si.edu

ABSTRACT

Accepted names, common names, and widely used synonyms for 347 species of grasses found in Maryland are reported. We provide information on their frequency, distribution, and conservation status.

RESUMEN

Se divulgan los nombres aceptados, nombres comunes, y los sinónimos ampliamente utilizados para 347 especies de pastos encontradas en Maryland. Proporcionamos información de su frecuencia, distribución, y estado de la conservación.

The grass family (Poaceae or Gramineae) is the fourth largest flowering plant family in the world and contains about 11,000 species in 800 genera worldwide. Twenty-three genera contain 100 or more species or about half of all grass species, and almost half of the 800 genera are monotypic or diatypic, i.e., with only one or two species (Watson & Dallwitz 1992, 1999). Specializations for open habitats and grazing tolerance, highly reduced floral structure, and wind pollination in the grasses have enabled the family to be extremely successful at planet-wide radiation and colonization. One notable feature of grasses and other monocots are intercalary meristems that allow individual culms to resprout once they have been removed. Grasses are well adapted to open, marginal, and frequently disturbed habitats, and can be found on every continent, including Antarctica.

With the infusion of molecular data our present concept and classification of the grasses is changing at a rapid rate. In Maryland we currently recognize eight subfamilies: Bambusoideae, Ehrhartoideae, Pooideae, Arundinoideae, Danthonoideae, Aristidoideae, Chloridoideae, and Panicoideae (Grass Phylogeny Working Group 2001; Soreng et al. 2009).

Over the last 120 years or so the flora of the eastern United States has been well documented. In Maryland, local treatments such as the flora of the District of Columbia and vicinity (Hitchcock 1919), Maryland grasses (Norton 1930), herbaceous plants of Maryland (Brown & Brown 1984), a checklist of plants in the Washington-Baltimore area (Hermann 1946), an annotated checklist of vascular plants of Rock Creek Park (Fleming & Canal 1995), an annotated list of the flora of Beltsville Agricultural Research Center (Terrell et al. 2000), and an annotated list of vascular plants of the Washington-Baltimore area (Shetler & Stone Orli 2002) have vastly improved our distribution records. Regional treatments have also contributed to an environmental awakening making the identification of grasses more accessible (Fernald 1950; Brown & Brown 1984; Gleason & Cronquist 1991).

The natural flora is always in a tenuous position since its survival is often in the hands of bureaucrats, politicians, and ultimately developers. Knowledge of our ever changing flora is critical to the conservation of our plant biodiversity, including the monitoring of native, introduced, and invasive species. We hope this annotated checklist will be useful to everyone who is concerned with maintaining our natural heritage and that it will serve as a useful step toward subsequent lists.

J. Bot. Res. Inst. Texas 3(2): 905 – 919. 2009

METHODS

We recognize four zones in Maryland: the coastal plain, piedmont, upper midland, and mountain. The coastal plain is east of Montgomery, Howard, Baltimore, Harford, and Cecil counties (Fig. 1) extending to Delaware and the Atlantic coast and including the lands surrounding the Chesapeake Bay. The piedmont, termed the lower midland zone in Brown & Brown (1984), includes all of the above-named five counties and the eastern part of Carroll County. The upper midland zone extends west through Washington County and a small part of Allegany County. This zone includes the northern extension of the Blue Ridge province and part of the Ridge and Valley province. The mountain zone includes most of Allegany County and all of Garrett County. This zone often has elevations above 1500 feet and its highest point is 3360 ft.

This annotated list is based on reports taken from publications and from collections at the University of Maryland (MARY) and the United States National Herbarium (US) at the National Museum of Natural History, Smithsonian Institution. The main source of distribution data was taken from Brown and Brown (1984) and often the first data listed here for a species have been taken from this source. In addition we consulted the Flora of North America, volumes 24 and 25 (Barkworth et al. 2003, 2007), a comprehensive treatment of the grasses. We cite Reed (1964) frequently because he investigated plants found on chrome, manganese, or other ore piles in the Canton area of the port district of Baltimore. Many of these species were first reports for North America or new to the DC area. Shetler and Stone Orli (2002) who produced a list for the DC area was also extensively consulted.

We include data from the Maryland Department of Natural Resources (list downloaded on 13 Nov 2007) concerning rare, threatened, and endangered species. There are no Maryland grasses federally listed as Endangered or Threatened. Seventy-three grass species are listed, including mostly species that are state-rare, regardless of how common they are in the other sections of their ranges, e.g., *Zizaniopsis miliacea* is very rare in Maryland, but frequent to common in the remainder of its range, Maryland to Florida and Texas and north to southeastern Missouri. Many other Maryland grasses have similar ranges, and are rated G5 for "demonstrably secure globally." In the present list we are concerned with species that are "globally rare". Consequently, we list here and in the text only 14 species that are designated G3 (very rare and local or with a restricted range) or G4 (secure globally but locally rare): *Amphicarpum amphicarpon* (G4), *Bromus nottowayanus* (G3-G5), *Calamagrostis porteri* (G4), *Dichanthelium aciculare* subsp. *aciculare* (G4-G5), *D. aciculare* subsp. *angustifolium* (G4-G5), *D. acuminatum* subsp. *leucothrix* (G4), *D. scabriusculum* (G4), *D. wrightianum* (G4), *Muhlenbergia glabriflora* (G4), *M. torreyana* (G3), *Panicum philadelphicum* subsp. *philadelphicum* (G3-G5), *Poa alsodes* (G4-G5), *P. saltuensis* subsp. *languida* (G3-G4), *Sphenopholis pensylvanica* (G4).

The following abbreviations are used in the list: **BARC**= Beltsville Agricultural Research Center; **DC**= District of Columbia; **DOV**= Phillips Herbarium, Delaware State College, Dover, Delaware; **MD**= Maryland, **MARY**= University of Maryland herbarium; **TAWES**= Herbarium of the Maryland Department of Natural Resources, Annapolis, Maryland; and **US**= United States National Herbarium. Accepted names appear in **bold,** synonyms appear in regular type, and an asterisk * designates introduced species.

ANNOTATED LIST OF GRASSES OF MARYLAND

AEGILOPS L.

**Aegilops. triuncialis* L. – barbed goat grass. Baltimore, chrome ore piles (Reed 1964).

(*AGROPYRON* Gaertn.)

Agropyron repens (L.) P. Beauv. = **Elymus repens**

AGROSTIS L. bentgrass.

Agrostis alba of authors = **Agrostis gigantea**

***Agrostis canina** L. – velvet bent. A lawn grass reported from Frederick Co.

***Agrostis capillaris** L. – Rhode Island bentgrass, colonial bentgrass. Collections at US: Montgomery, Prince George's, Garrett, Somerset, Wicomico cos. (all det. by M. Harvey). Locally common in lawns and fields in Montgomery and Prince George's cos. (Terrell collections), probably occurs more widely in MD.

Agrostis elliottiana Schult. – Elliott's bentgrass. Reported from Charles County (Shetler & Stone Orli 2002). No collections at MARY or US.

***Agrostis gigantea** Roth – redtop. (*A. alba* L., misapplied). Common and widespread.

Agrostis hyemalis (Walter) Britton, Sterns, & Poggenb. – ticklegrass. Common.

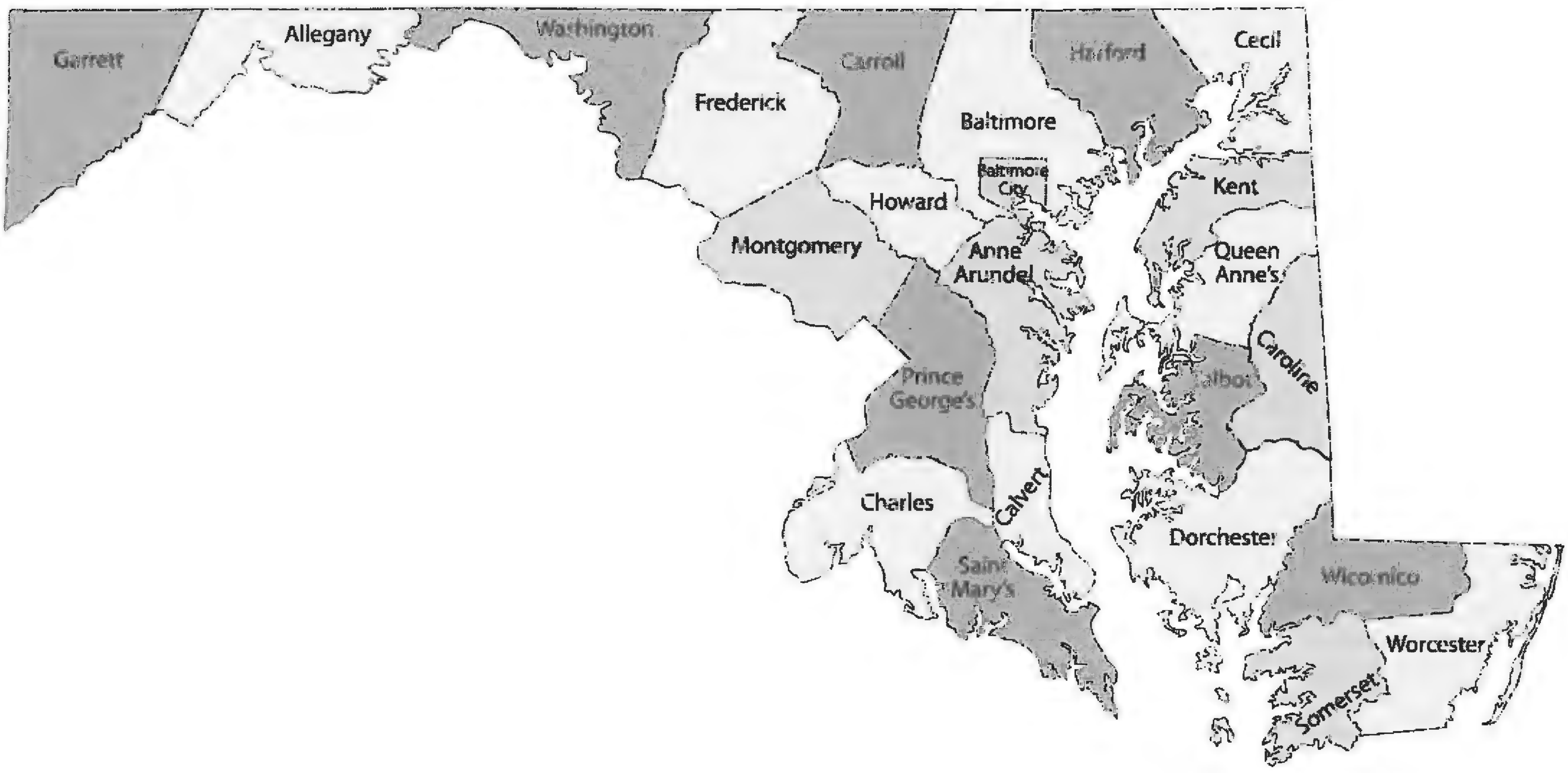


Fig. 1. Location of counties in Maryland.

Agrostis mertensii Trin. – northern bent. Reported by Reed (1986).

Agrostis perennans (Walter) Tuck. – upland bentgrass. Frequent in piedmont and coastal plain.

Agrostis scabra Willd. – rough bentgrass. (*A. hyemalis* var. *scabra* (Willd.) Blomq. Rather widespread.

Agrostis spica-venti L. = **Apera spica-venti**

***Agrostis stolonifera** L. – creeping bentgrass. Widespread in suitably moist habitats.

Agrostis tenuis Sibth. = **A. capillaris**

AIRA L. Hairgrass.

Aira capillaris Host = **A. caryophyllea** var. **capillaris**

***Aira caryophyllea** L.

var **capillaris** (Mert. & W.D.J. Koch) Bluff & Fingerh. – delicate hairgrass. Rare, Worcester Co. and south.

var. **caryophyllea** – silver hairgrass. Frequent on coastal plain. Common at BARC, Prince George's Co. (Terrell et al. 2000).

Aira elegans Willd. ex Roem. & Schult. = **A. caryophyllea** var. **capillaris**

***Aira praecox** L. – spike hairgrass. Prince George's, Calvert, Worcester cos. Rare on southern coastal plain.

ALLOTEROPSIS J.Presl

***Alloteropsis cimicina** (L.) Stapf – Baltimore, ore piles (Reed 1964). (*Coridochloa cimicina* (L.) Nees ex B.D. Jacks.).

ALOPECURUS L.

Alopecurus aequalis Sobol. var. **aequalis** – short-awn foxtail. Rare, Cecil Co. Prince George's Co., two collections from BARC (Terrell et al. 2000). Spreading via agricultural equipment on Delmarva, likely adventive (Frye).

Alopecurus carolinianus Walter – tufted foxtail. Infrequent, an agricultural weed of field edges (Frye).

***Alopecurus geniculatus** L. – marsh foxtail. Rare. Dorchester Co. and DC area. Prince George's Co., Oxon Run (Shetler & Stone Orli 2002).

***Alopecurus myosuroides** Huds. – slender foxtail. Rare, DC area. Baltimore, chrome ore piles (Reed 1964). Prince George's Co., Beltsville (Shetler & Stone Orli 2002).

***Alopecurus pratensis** L. – meadow foxtail. Rare. Dorchester Co. Prince George's Co. (Shetler & Stone Orli 2002). Montgomery Co., Terrell collection.

AMMOPHILA Host Beachgrass.

Ammophila arenaria (L.) Link – European beachgrass. Occasionally introduced. Reported by Kartesz & Meacham (2008).

Ammophila breviligulata Fernald – American beachgrass. Ocean and bay beaches and dunes. Widely planted to prevent erosion.

AMPHICARPUM Kunth

Amphicarpum amphicarpon (Pursh) Nash – blue maidencane. Locally abundant, coastal plain. G4.

Amphicarpum purshii Kunth = **A. amphicarpon**

ANDROPOGON L. Bluestem.

Andropogon elliottii Chapm. = **A. gyrans**

Andropogon gerardii Vitman – big bluestem. Infrequent throughout. Widely planted in warm season grass mixes (Frye).

Andropogon glomeratus (Walter) Britton, Sterns, & Poggenb.

var. **glaucopsis** (Elliott) C. Mohr – Reported by Kartesz & Meacham (2008).

var. **glomeratus** – bushy bluestem. Common, coastal plain.

var. **hirsutior** (Hack.) C. Mohr – Reported by Kartesz & Meacham (2008).

Andropogon gyrans Ashe var. **gyrans** – Elliott's bluestem. Coastal plain.

Andropogon scoparius Michx.= **Schizachyrium scoparium**

Andropogon ternarius Michx.var. **ternarius** – split bluestem. Coastal plain, infrequent.

Andropogon virginicus L.
  var. **virginicus** – broomsedge bluestem. Widespread and abundant.
  var. *abbreviatus* (Hack.) Fernald & Griscom = **A. glomeratus**

ANTHOXANTHUM L.

***Anthoxanthum hirtum** (Schrank) Y. Schouten & Veldkamp – Reported by Kartesz & Meacham (2008).

***Anthoxanthum nitens** (Weber) Y. Schouten & Veldkamp – vanilla sweetgrass. *Hierochloë odorata* (L.) Wahlenb. treated as synonym in Allred & Barkworth (2007: 762). Rare. Baltimore Co, Soldiers Delight, 4 May 1980, *Reveal & Broome 5133* (MARY).

***Anthoxanthum odoratum** L. – sweet vernal grass. Abundant weed throughout MD.

APERA Adans.

***Apera spica-venti** (L.) P. Beauv. – Weed in grass plots, College Park, Prince George's Co.

APLUDA L.

***Apluda mutica** L. – Baltimore, chrome ore piles (Reed 1964).

ARISTIDA L. Three-awn grass

Aristida adscensionis L. – Baltimore, chrome ore piles (Reed 1964).

Aristida curtissii (A. Gray) Nash = **A. dichotoma** var. **curtissii**

Aristida dichotoma Michx.
  var. **curtissii** A. Gray – Curtiss's three-awn grass. Uncommon, coastal plain and piedmont. Prince George's Co., BARC (Terrell et al. 2000).
  var. **dichotoma** – Common, coastal plain and piedmont.

Aristida lanosa Muhl. ex Elliott – woolly three-awn grass. Rare, eastern shore.

Aristida longespica Poir.
  var. **geniculata** (Raf.) Fernald – Reported by Kartesz & Meacham (2008).
  var. **longespica** – Frequent, coastal plain and lower piedmont.

Aristida oligantha Michx. – oldfield three-awn grass. Fairly common, coastal plain and DC area.

Aristida purpurascens Poir.
  var. **purpurascens** – purple three-awn grass. Frequent, coastal plain.
  var. **virgata** (Trin.) Allred – Rare, eastern shore. Five collections from Wicomico and Worcester cos. in TAWES (Frye).

Aristida tuberculosa Nutt. – seaside three-awn grass. Rare, Assateague Island, Worcester Co.

ARRHENATHERUM P. Beauv.

***Arrhenatherum elatius** (L.) P. Beauv. ex J. Presl & C. Presl
  var. **elatius** – tall oatgrass. Naturalized, sometimes planted. Rather infrequent, mostly in the piedmont.
  var. **bulbosum** (Willd.) Spenner – Reported from southern eastern shore.

ARTHRAXON P. Beauv.

***Arthraxon hispidus** (Thunb.) Makino – arthraxon, small carp grass. Common and widespread weed.

ARUNDINARIA Michx. Cane

Arundinaria tecta (Walter) Muhl. – switch cane. Rare, coastal plain.

ARUNDO L. Reed

***Arundo donax** L. – giant reed. Grown as ornamental. Established in Wicomico Co.

AVENA L. Oats

***Avena fatua** L. – wild oats. Rare. Baltimore, chrome ore piles (Reed 1964).

***Avena sativa** L. – Oats. Cultivated, sometimes escaped and established.

AVENELLA (Bluff & Fingerh.) Drejer

Avenella flexuosa (L.) Drejer – crinkled hairgrass. Frequent, northern coastal plain and mountains.

AXONOPUS P. Beauv.

Axonopus furcatus (Flüggé) Hitchc. – big carpetgrass. Uncommon, coastal plain. None in MARY, US. Locally abundant in Somerset Co. (Frye).

BOTHRIOCHLOA Kuntze

***Bothriochloa pertusa** (L.) A. Camus – Baltimore, chrome ore piles (Reed 1964).

BOUTELOUA Lag. Grama grass.

***Bouteloua aristidoides** (Kunth) Griseb. – Baltimore, chrome ore piles (Reed 1964).

***Bouteloua barbata** Lag. – Baltimore, chrome ore piles (Reed 1964).

Bouteloua curtipendula (Michx.) Torr. – side-oats grama. Rare, ridge and valley (Frye). Montgomery, Baltimore, Washington, Allegany cos. (Brown & Brown 1984).

Bouteloua hirsuta Lag. – Reported by Kartesz & Meacham (2008).

BRACHIARIA (Trin.) Griseb. = **UROCHLOA**, in part

Brachiaria distachya (L.) Stapf = **Urochloa distachya**

Brachiaria eruciformis (Sm.) Griseb. = **Moorochloa eruciformis**

BRACHYELYTRUM. P. Beauv.

Brachyelytrum aristosum (Michx.) P. Beauv. ex Branner & Coville – Garrett Co. (Saarela et al. 2003).

Brachyelytrum erectum (Schreb.) P. Beauv. – Fairly common, piedmont and mountains.

BRIZA L. Quaking grass.

***Briza media** L. – Rare. No data (Brown & Brown 1984).

***Briza minor** – little quaking grass. Rarely established; Assateague Island, Worcester Co. (Brown & Brown 1984).

BROMUS L. Brome grass.

***Bromus arvensis** L. – field bromegrass. Rare, Prince George's, Worcester, and Talbot cos.

***Bromus briziformis** Fisch. & C.A.Mey. – awnless brome. Rare, Baltimore and Dorchester cos.

***Bromus catharticus** Vahl – rescue grass. Uncommon. Prince George's Co., BARC (Terrell et al. 2000).

Bromus ciliatus L.
var. **ciliatus** – fringed bromegrass. Reported from Maryland, needing taxonomic study (Frye).

Bromus ciliatus var. *laeviglumis* Scribn. = **B. pubescens**.

***Bromus commutatus** Schrad. – hairy chess, meadow brome. Common and widespread weed.

***Bromus diandrus** Roth – ripgut grass. Local and rare, inner coastal plain. (*B. rigidus* in Brown & Brown 1984).

Bromus dudleyi Fernald= **B. ciliatus**

***Bromus hordeaceus** L. subsp. **hordeaceus** – soft chess, soft brome. Known from several counties (*B. mollis* in Brown & Brown 1984). Prince George's Co., BARC (Terrell et al. 2000).

***Bromus inermis** Leyss. – smooth brome. Sometimes grown, but established widely in a variety of habitats.

***Bromus japonicus** Thunb. – Japanese brome, Japanese chess. Known from four counties but common weed in BARC, Prince George's Co. (Terrell et al. 2000) and probably more widely distributed.

***Bromus kalmii** A. Gray – Rare, Garrett Co.

Bromus latiglumis (Shear) Hitchc. – Rare, coastal plain and along Potomac River.

**Bromus madritensis* L. Cultivated as ornamental. Listed by Guala & Bogler (2004).

Bromus mollis L. = **B. hordeaceus**

Bromus nottowayanus Fernald – Rare, Baltimore and Montgomery cos. (Brown & Brown 1984). In calcareous habitats throughout Maryland (Frye). G3–G5.

Bromus pubescens Muhl. ex Willd. – Canada brome. Common in piedmont, also in Garrett and Allegany Cos., often referred to as *B. ciliatus* var. *laeviglumis* (*B. purgans* in Brown & Brown 1984).

Bromus purgans L. = **B. pubescens**

Bromus racemosus L. – Uncommon, reported from Anne Arundel, Baltimore, Howard, Kent, Prince George's, Montgomery and Queen Anne's cos.

Bromus rigidus Roth = **B. diandrus**

***Bromus rubens** L. – foxtail chess. Rare, reported from Worcester Co.

***Bromus secalinus** L. – chess, cheat. Common and widespread.

***Bromus sterilis** L. – barren brome, poverty brome. Uncommon. Weed in Prince George's Co., BARC (Terrell et al. 2000). In 2008 abundant in Frederick Co. and in parts of Montgomery Co. (seen by Terrell).

***Bromus tectorum** L. – downy chess, downy brome. Common weed.

Bromus unioloides Kunth = **B. catharticus**

Bromus villosus Forssk. = **B. diandrus**

CALAMAGROSTIS Adans. Reed Bentgrass.

Calamagrostis canadensis (Michx.) P. Beauv. var. **canadensis** – bluejoint. Infrequent. Garrett, Montgomery, and Prince George's cos. (Brown & Brown 1984).

Calamagrostis cinnoides (Muhl.) W.P.C.Bart.) – small reedgrass. A proposal is planned to preserve this name over the name *C. coarctata* Torr. ex Eaton (Marr et al. 2007: 717). Widespread.

Calamagrostis porteri A. Gray subsp. **porteri** – Reported by Kartesz & Meacham (2008). G4.

CENCHRUS L. Sandbur.

***Cenchrus echinatus** L. – Baltimore, chrome ore piles (Reed 1964).

Cenchrus longispinus (Hack.) Fernald – field sandbur. Infrequent. Prince Georges Co., BARC (Terrell et al. 2000).

Cenchrus spinifex Cav. – coastal sandbur. Reported by Kartesz & Meacham (2008).

Cenchrus tribuloides L. – dune sandbur. Common in coastal plain.

(CHAETOCHLOA Scribn.) = **SETARIA**

CHASMANTHIUM Link

Chasmanthium latifolium (Michx.) H. O. Yates – Indian wood oats. (*Uniola latifolia* Michx.) Frequent in Potomac drainage.

Chasmanthium laxum (L.) H. O. Yates – slender wood oats. (*Uniola laxa* (L.) BSP.). Chiefly in coastal plain where frequent.

CHLORIS Sw. Finger Grass.

***Chloris verticillata** Nutt. – windmill grass. Established in field adjoining library in BARC, Prince George's Co. (Terrell et al. 2000).

***Chloris virgata** Sw. – Baltimore, chrome ore piles (Reed 1964).

CINNA L. Woodreed.

Cinna arundinacea L. – Woodreed. Common throughout.

Cinna latifolia (Trevir. ex Göpp.) Griseb. – drooping woodreed. Infrequent in mountain zone.

COELORACHIS Brongn.

Coelorachis rugosa (Nutt.) Nash – wrinkled jointgrass. Rare in southern eastern shore (as *Manisuris rugosa* in Brown & Brown 1984). No specimens from MD in MARY.

CYNODON Rich.

***Cynodon dactylon** (l.) Pers. – Bermuda grass. Planted in lawns and widely established as a weed.

CYNOSURUS L. Dog's-tail Grass.

***Cynosurus cristatus** L. – crested dog's-tail grass. Rare weed. College Park, Prince George's Co. (Shetler & Stone Orli 2002).

***Cynosurus echinatus** L. – Rare weed reported from MD.

DACTYLIS L. Orchard Grass.

***Dactylis glomerata** L. – orchard grass. Common and widespread. Sometimes cultivated.

DACTYLOCTENIUM Willd.

***Dactyloctenium aegyptium** (L.) Willd. – Rare or absent. One collection *Pond s.n.* (MARY) as a weed in farm plots, College Park.

***Dactyloctenium geminatum** Hack. – Baltimore, chrome ore piles (Reed 1964).

DANTHONIA Lam.& DC. Wild Oatgrass.

Danthonia compressa Aust. – mountain oatgrass. Common in western MD, also Frederick, Montgomery, Prince George's, and Calvert cos.

Danthonia sericea Nutt. – downy oatgrass. Common in Dorchester, Wicomico, and Worcester cos. and in coastal plain.

Danthonia spicata (L.) P. Beauv. ex Roem. & Schult. – poverty grass. Common and widespread.

DASYOCHLOA Willd. ex Rydb.

***Dasyochloa pulchella** (Kunth) Willd. ex Rydb. – Baltimore, chrome ore piles (Reed 1964).

DESCHAMPSIA P. Beauv. Hairgrass.

Deschampsia caespitosa (L.) P. Beauv. – tufted hairgrass. Reported from Baltimore Co. No collections in MARY, US. Several collections at TAWES (Frye).

Deschampsia flexuosa (L.) Trin.= **Avenella flexuosa**

DIARRHENA P. Beauv.

Diarrhena americana P. Beauv. – American beakgrain. Possibly erroneously reported in Maryland (Brandenburg 2007: 65), recent collections have all been **D. obovata**.

Diarrhena obovata (Gleason) Brandenburg – obovate beakgrain. Collected during years 2002- 2007 from Montgomery to Allegany counties along the Potomac River by *C. Lea*, (DOV, US). R.J. Soreng recently collected it near the American Legion Bridge and at Bear Island, Montgomery Co., personal collections.

DICHANTHELIUM (Hitchc. & Chase) Gould

Subspecies here are sometimes varieties in Brown & Brown (1984). Some species listed by Guala & Bogler (2004) are subspecies. M. Lelong determined some taxa collected in Prince George's Co.

Dichanthelium aciculare (Desv. ex Poir.) Gould & C.A.Clark – narrow-leaved panicgrass.
 subsp. **aciculare**. – Rare in coastal plain. G4–G5.
 subsp. **angustifolium** (Elliott) Freckmann & Lelong (*D. angustifolium* (Elliott) Gould)– As a synonym of *D. aciculare* var. *aciculare* in Brown & Brown (1984). No data. G4–G5.

Dichanthelium acuminatum (Sw.) Gould & C.A. Clark – hairy panicgrass.
 subsp. **acuminatum** (var. *acuminatum*) – Infrequent in coastal plain.
 subsp. **columbianum** (Scribn.) Freckmann & Lelong. As *D. sabulorum* var. *thinum* (Hitchc. & Chase) Gould & C.A. Clark in Brown & Brown (1984). Occurs in coastal plain.
 subsp. **fasciculatum** (Torr.) Freckmann & Lelong. Widespread.
 subsp. **implicatum** (Scribn) Freckmann & Lelong. Piedmont and coastal plain.
 subsp. **leucothrix** (Nash) Freckmann & Lelong. As *D. acuminatum* var. *implicatum* (Scribn.) Gould & C.A. Clark in Brown & Brown (1984). No data. G4.
 subsp. **lindheimeri** (Nash) Freckmann & Lelong. Frequent.
 subsp. **longiligulatum** (Nash) Freckmann & Lelong. Coastal plain.
 subsp. **spretum** (Schult) Freckmann & Lelong. As *D. acuminatum* var. *densiflorum* (E.L. Rand & Redfield) Gould & C.A. Clark in Brown and Brown (1984). Coastal plain.

Dichanthelium angustifolium (Elliott) Gould = **D. aciculare**

Dichanthelium boreale (Nash) Freckman – northern panic grass. No data.

Dichanthelium boscii (Poir.) Gould & C. A. Clark – Bosc's panicgrass. Common.

Dichanthelium clandestinum (L.) Gould – deer-tongue grass. Common and widespread.

Dichanthelium commutatum (Schult.) Gould – variable panicgrass.
 subsp. **ashei** (T.G. Pearson ex Ashe) Freckmann & Lelong. No data.
 subsp. **commutatum** – Frequent.

Dichanthelium depauperatum (Muhl.) Gould – starved panic grass. Frequent in coastal plain and piedmont.

Dichanthelium dichotomum (L.) Gould – forked panic grass, bushy panic grass.
 subsp. **dichotomum** – Common.
 subsp. **lucidum** (Ashe) Freckmann & Lelong. No data.
 subsp. **microcarpon** (Muhl. ex Elliott) Freckmann & Lelong. – Common.
 subsp. **yadkinense** (Ashe) Freckmann & Lelong. No data

Dichanthelium ensifolium (Baldwin ex Elliott) Gould – sword-leaf panic grass. No data.

Dichanthelium latifolium (L.) Harvill – broad-leaved panic grass.Infrequent in piedmont.

Dichanthelium laxiflorum (Lam.) Gould – soft-tufted panicgrass. Rare in MD.

Dichanthelium linearifolium (Scribn.) Gould – linear-leaved panicgrass, low panic grass. No data.

Dichanthelium meridionale (Ashe) Freckmann. Reported by Kartesz & Meacham (2008). = **D. acuminatum** subsp. **implicatum**

Dichanthelium oligosanthes (Schult.) Gould – few-flowered panicgrass.
 subsp. **oligosanthes** – Infrequent, coastal plain.
 subsp. **scribnerianum** (Nash) Freckmann & Lelong – Infrequent, piedmont.

Dichanthelium ovale (Elliott) Gould & C.A.Clark – stiff-leaved panicgrass.
 subsp. **ovale** – Rare, coastal dunes.
 subsp. **pseudopubescens** (Nash) Freckmann & Lelong – Rare.
 subsp. **villosissimum** (Nash) Freckmann & Lelong. No data.

Dichanthelium polyanthes (Schult.) Mohlenbr. – many-flowered panic grass. As *D. sphaerocarpon* var. *isophyllum* (Scribn.) Gould & C.A. Clark in Brown & Brown 1984). Common.

Dichanthelium portoricense (Desv. ex Ham.) B.F. Hansen & Wunderlin
 subsp. **patulum** (Scribn. & Merr.) Freckmann & Lelong – blunt-glumed panicgrass. No data.

Dichanthelium ravenelii (Scribn & Merr.) Gould – Ravenel's panic grass. Rare in coastal plain.

Dichanthelium sabulorum (Lam.) Gould & C.A. Clark
 var. *patulum* = **D. portoricense** subsp. **patulum**
 var. *thinium* = **D. acuminatum** subsp. **columbianum**

Dichanthelium scabriusculum (Ell.) Gould & C.A. Clark – Uncommon in coastal plain. Wicomico Co. G4.

Dichanthelium scoparium (Lam.) Gould – velvety panicgrass. Common in eastern MD and coastal plain.

Dichanthelium sphaerocarpon (Elliott) Gould – round-fruited panicgrass. Common.

Dichanthelium tenue (Muhl.) Freckmann & Lelong – Reported by Kartesz & Meacham (2008).

Dichanthelium villosissimum = **D. ovale** subsp. **villosissimum**

Dichanthelium wrightianum (Scribn.) Freckmann – Reported by Kartesz & Meacham (2008). G4.

DIGITARIA Haller Crab Grass, Finger Grass.

Digitaria ciliaris (Retz.) Koeler – southern crabgrass. Probably common.

Digitaria cognata (Schult.) Pilg. – fall witchgrass. (*Leptoloma cognata* (Schult.) Chase). Anne Arundel Co. (Shetler & Stone Orli 2002), Prince George's Co., BARC (Terrell et al. 2000). Frequent on coastal plain (Frye).

Digitaria filiformis (L.) Koeler – slender crabgrass. Frequent, coastal plain.

*__Digitaria ischaemum__ (Schreb.) Muhl. – smooth crabgrass. Common and widespread weed.

Digitaria longiflora (Retz.) Pers. – Baltimore, chrome ore piles (Reed 1964).

*__Digitaria sanguinalis__ (L.) Scop. – hairy crabgrass. Common and widespread weed.

DINEBRA Jacq.

*__Dinebra retroflexa__ (Vahl) Panz. – Baltimore, chrome ore piles (Reed 1964).

DISTICHLIS Raf. Saltgrass.

Distichlis spicata (L.) Greene – seashore saltgrass. Common in salt marshes, coastal plain.

ECHINOCHLOA P. Beauv.

*__Echinochloa colona__ (L.) Link – awnless barnyard grass. Baltimore, chrome and manganese ore piles (Reed 1964). Baltimore Co., *Riefner 78-721* (MARY). Prince George's Co., BARC (Terrell et al. 2000).

*__Echinochloa crusgalli__ (L.) P. Beauv. – barnyard grass. Common and widespread.

*__Echinochloa crus-pavonis__ (Kunth) Hitchc. – Baltimore, chrome ore piles (Reed 1964).

Echinochloa frumentacea Link – Reported by Kartesz & Meacham (2008).

Echinochloa muricata (P. Beauv.) Fernald – Rare in MD.
  var. **microstachya** Wiegand – Prince George's Co., BARC (Terrell et al. 2000).
  var. **muricata** – Prince George's Co.,BARC (Terrell et al. 2000).

Echinochloa walteri (Pursh) A. Heller – Walter's barnyard grass. Common, coastal plain.

ELEUSINE Gaertn. Goose Grass.

*__Eleusine indica__ (L.) Gaertn. – goose grass. Common weed especially on sidewalks and paved places.

ELYMUS L. Wildrye.

Elymus canadensis L. – Canada wildrye. Limestone regions, northern counties, Prince George's, Talbot cos.

Elymus hystrix L. – bottlebrush grass.
  var. **hystrix**. – Widespread. (*Hystrix patula* Moench).
  var. **bigelovianus** (Fernald) Bowden – Reported by Kartesz & Meacham (2008).

Elymus macgregorii R. Brooks & J.J.N. Campb. – early wildrye. Reported by Kartesz & Meacham (2008).

*__Elymus repens__ (L.) Gould – quackgrass. Common and widespread weed.

Elymus riparius Wiegand – riverbank wildrye. Frequent, piedmont and Worcester Co.

Elymus trachycaulus (Link) Gould
  subsp. **subsecundus** (Link) A. Löve & D. Löve – Reported by Kartesz & Meacham (2008).
  subsp. **trachycaulus** – Reported by Kartesz & Meacham (2008).

Elymus villosus Muhl. ex Willd. – slender wildrye. Infrequent, piedmont and coastal plain.

Elymus virginicus L.
  var. **halophilus** (E. P. Bicknell) Wiegand. – Reported by Kartesz & Meacham (2008),.
  var. **virginicus**. – Virginia wildrye. Frequent and widespread.

(*ELYTRIGIA* Desv.) =**ELYMUS**

Elytrigia repens (L.) Desv. ex Nevski =**Elymus repens**

ENNEAPOGON Desv. ex P. Beauv.

*__Enneapogon desvauxii__ P. Beauv. – Baltimore, chrome ore piles (Reed 1964).

ERAGROSTIS P. Beauv. Lovegrass

*__Eragrostis barrelieri__ Daveau – Baltimore, manganese ore piles (Reed 1964).

Eragrostis capillaris (L.) Nees – lacegrass. Common, piedmont, infrequent in coastal plain.

*__Eragrostis cilianensis__ (All.) Vignolo ex Janch. – stinkgrass. Common weed in gardens and waste places throughout.

*__Eragrostis curvula__ (Schrad.) Nees – weeping lovegrass. Planted on roadsides as erosion preventive and used for reclamation, often escaped and established (Peterson 2003a: 76).

*__Eragrostis cylindriflora__ Hochst. – Baltimore, manganese ore piles (Reed 1964).

Eragrostis frankii C. A. Mey. ex Steud. – Frank's lovegrass. Piedmont, infrequent.

Eragrostis hirsuta (Michx.) Nees – big-top lovegrass Common on coastal plain (Frye).

Eragrostis hypnoides (Lam.) Britton, Sterns, & Poggenb. – Uncommon in piedmont.

Eragrostis megastachya (Koeler) Link = **E. cilianensis**

*__Eragrostis mexicana__ (Hornem.) Link
  subsp. **mexicana** – Mexican lovegrass. Rare, known from Prince George's Co.
  subsp. **virescens** (J. Presl) S.D. Koch & Sánchez Vega. – Reported by Kartesz & Meacham (2002).

*__Eragrostis minor__ Host – Infrequent; piedmont.

Eragrostis pectinacea (Michx.) Nees var. **pectinacea** weedy lovegrass – Common and widespread weed.

*__Eragrostis pilosa__ (L.) P. Beauv. var. **pilosa** – India lovegrass. Frequent in piedmont and coastal plain, more common east of Chesapeake Bay.

Eragrostis poaeoides P. Beauv. ex Roem. & Schult. = **E. minor**

Eragrostis refracta (Muhl.) Scribn. – Infrequent, reported from Wicomico and Worcester cos.

Eragrostis spectabilis (Pursh) Steud. – purple lovegrass. Common and widespread.

***Eragrostis suaveolens** Becker ex Claus – sweet lovegrass. Prince George's Co. (Shetler & Stone Orli 2002)

***Eragrostis trichophora** Coss. & Durieu – Baltimore, Chrome ore piles (Reed 1964).

***Eragrostis unioloides** (Retz.) Nees ex Steud. – Baltimore, chrome ore piles (Reed 1964).

(*ERIANTHUS* Michx.) = SACCHARUM

Erianthus alopecuroides (L.) Ell. = **Saccharum alopecuroides**

Erianthus brevibarbis Michx.= **S. brevibarbe**

Erianthus. coarctatus Fernald= **S. coarctatum**

Erianthus contortus Ell. = **S. brevibarbe** var. **contortum**

Erianthus giganteus (Walt.) Muhl. **= S. giganteum**

Erianthus ravennae (L.) Beauv.= **S. ravennae**

ERIOCHLOA Kunth

***Eriochloa acuminata** (J. Presl) Kunth – Baltimore, chrome ore piles (Reed 1964).

var. **minor** (Vasey) R.B. Shaw – Reported by Kartesz & Meacham (2008).

***Eriochloa punctata** (L.) Desv. ex Ham. – Baltimore, chrome ore piles (Reed 1964).

(*EULALIA* Kunth)

Eulalia vimineum (Trin.) A. Camus = **Microstegium vimineum**

FESTUCA L. Fescue.

Festuca arundinacea Schreb. = **Schedonorus arundinaceus**

Festuca brevipila = **F. trachyphylla**

Festuca duriuscula L. = **F. trachyphylla**

Festuca elatior L. = **Schedonorus arundinaceus**

***Festuca filiformis** Pourr. – hair fescue. Howard Co. Escaped from cultivation.

Festuca longifolia Thuill. =**F. trachyphylla**

Festuca obtusa Biehler = **F. subverticellata**

Festuca ovina L. – sheep fescue. Planted as ornamental.

Festuca paradoxa Desv. – cluster fescue. Rare, Garrett Co. and Susquehanna Valley (Brown & Brown 1984). Apparently rare with few records (Frye).

Festuca pratensis Huds. = **Schedonorus pratensis**

***Festuca rubra** L. – red fescue.

subsp. **commutata** Gaudin – Chewings fescue. Planted for lawns and established elsewhere.

subsp. **fallax** (Thuill.) Nyman – Planted.

subsp. **rubra**. Planted.

Festuca subverticellata (Pers.) E. B. Alexeev – nodding fescue. Common throughout (Frye).

Festuca tenuifolia Sibth. = **F. filiformis**

***Festuca trachyphylla** (Hack.) Krajina – hard fescue. Naturalized. Established in BARC, Prince George's Co. (Terrell et al. 2000).

GLYCERIA R. Br. Manna Grass.

Glyceria acutiflora Torr. – Rare on coastal plain and Blue Ridge (Frye).

Glyceria canadensis (Michx.) Trin.

var. **canadensis** – rattlesnake grass. Mountain counties.

var. **laxa** (Scribn) Hitchc. – Listed as a species in coastal plain, piedmont and mountain zones (Brown & Brown 1984).

***Glyceria fluitans** (L.) R. Br. – water manna grass Reported from Baltimore. Co.

Glyceria grandis S. Watson – Reported by Kartesz & Meacham (2008).

*Glyceria laxa (*Scribn.) Scribn. = **G. canadensis** var. **laxa**

Glyceria melicaria (Michx.) F.T. Hubb. – melic manna grass. Infrequent, mountain and piedmont.

Glyceria obtusa (Muhl.) Trin. – Atlantic manna grass. Common in coastal plain.

Glyceria septentrionalis Hitchc. – northern manna grass. Frequent in coastal plain.

Glyceria striata (Lam.) Hitchc. – fowl manna grass. Widespread and common.

GYMNOPOGON P.Beauv. Beardgrass.

Gymnopogon ambiguus (Michx.) Britton, Sterns, & Poggenb. – Frequent in coastal plain.

Gymnopogon brevifolius Trin. – Rare, Worcester and Wicomico cos.

HACKELOCHLOA Kuntze

***Hackelochloa granularis** (L.) Kuntze – Baltimore, chrome ore piles (Reed 1964).

(*HIEROCHLOË* R. Br.) = ANTHOXANTHUM

Hierochloë hirta (Schrank) Borbás = **Anthoxanthum hirtum**

Hierochloë odorata (L.) Wahlenb. = **Anthoxanthum nitens**

HOLCUS L. Velvet Grass.

***Holcus lanatus** L. – velvet grass. Common weed.

HORDEUM L. Barley.

Hordeum brachyantherum Nevski – Reported by Kartesz & Meacham (2008).

***Hordeum jubatum** L. – foxtail barley. Infrequent mostly on coastal plain. Prince George's Co. BARC, (Terrell et al. 2000).

***Hordeum marinum** Huds. – Baltimore, chrome ore piles (Reed 1964).

***Hordeum murinum** L.

subsp. **leporinum** (Link) Arcang. – Reported by Kartesz & Meacham (2008).

subsp. **murinum** – Baltimore, chrome ore piles (Reed 1964).

Hordeum pusillum Nutt. – little barley. Frequent in coastal plain.

***Hordeum vulgare** L. – barley. Cultivated, escaping, not persisting.

HYSTRIX Moench

Hystrix patula Moench = **Elymus hystrix**

ISCHAEMUM L.

***Ischaemum indicum** (Houtt.) Merr. – Baltimore, chrome ore piles (Reed 1964).

***Ischaemum rugosum** Salisb. – Baltimore, chrome ore piles (Reed 1964).

KOELERIA Pers.

Koeleria macrantha (Ledeb.) Schult. – Junegrass. A western species cited by Kartesz & Meacham (2008) and listed by Guala & Bogler (2004), but no records found.

Koeleria phleoides (Vill.) Pers. = **Rostraria cristata**

LEERSIA Sw.

Leersia hexandra Sw. – southern cutgrass. Rare. Data lacking.

Leersia lenticularis Michx. – catch-fly grass. Rare, Worcester Co.

Leersia oryzoides (L.) Sw. – rice cutgrass. Widespread.

Leersia virginica Willd. – white cutgrass. Widespread.

LEPTOCHLOA P. Beauv.

***Leptochloa dubia** (Kunth) Nees – Baltimore, chrome ore piles (Reed 1964).

Leptochloa fusca (L.) Kunth subsp. **fascicularis** (Lam.) N. Snow – feather grass. (*Leptochloa fascicularis* var. *maritima* (E.P. Bicknell) Gleason). Uncommon, coastal plain, Calvert Co., Cove Point (Steury 1997).

Leptochloa panicea (Retz.) Ohwi subsp. **brachiata** (Steud.) N. Snow – Reported by Kartesz & Meacham (2008).

LEPTOLOMA Chase

Leptoloma cognata (Schult.) Chase = **Digitaria cognata**

LOLIUM L. Ryegrass.

***Lolium multiflorum** Lam. – annual ryegrass, Italian ryegrass. Often planted. Widespread weed.

***Lolium perenne** L. – perennial ryegrass. Often planted. Widespread weed.

***Lolium temulentum** L. – darnel. Uncommon weed. Baltimore, chrome ore piles (Reed 1964).

MANISURIS L.

Manisuris rugosa (Nutt.) Kuntze = **Coelorachis rugosa**

MELICA L. Melic Grass.

Melica mutica Walter – two-flowered melic. Rare, southern MD and piedmont (Frye).

Melica nitens (Scribn.) Nutt. ex Piper – Rare, ridge and valley (Frye).

MELINIS P. Beauv.

***Melinis repens** (Willd.) Zizka – Natal grass. (*Rhynchelytrum repens* (Willd.) C.E.Hubb.). Treated as synonym by Zizka (1988). Baltimore, chrome and manganese ore piles (Reed 1964).

MICROSTEGIUM Nees

***Microstegium vimineum** (Trin.) A. Camus – cover-all grass, stilt grass, Nepalese browntop. Widespread noxious weed.

MILIUM L.

Milium effusum L. var. **cisatlanticum** Fernald – tall millet grass. Locally abundant in Garrett Co. (Frye). Collections from MD in MARY.

MISCANTHUS Andersson

***Miscanthus sinensis** Andersson – miscanthus. Widely planted, frequently escaped.

MNESITHEA Kunth

Mnesithea granularis (L.) de Koning & Sosef. = **Hackelochloa granularis**

Mnesithea rugosa (Nutt.) de Koning & Sosef. = **Coelorachis rugosa**

MOOROCHLOA Veldkamp.

A new genus as treated by Veldkamp (2004).

***Moorochloa eruciformis** (Sm.) Veldkamp – Baltimore, chrome ore piles (Reed 1964). Formerly placed under *Brachiaria*.

MUHLENBERGIA Schreb.

***Muhlenbergia asperifolia** (Nees & Meyen ex Trin.) Parodi – Frederick Co. (Reed 1964).

Muhlenbergia capillaris (Lam.) Trin. – DC area.

Muhlenbergia frondosa (Poir.) Fernald – wirestem muhly. Baltimore, Frederick, Howard, and Montgomery cos.

Muhlenbergia glabriflora Scribn. – Hyattsville, Prince George's Co., *Scribner s.n.* at US (Shetler & Stone Orli 2002). G4.

Muhlenbergia glomerata (Willd.) Trin. – Reported by Kartesz & Meacham 2008.

Muhlenbergia mexicana (L.) Trin. – Infrequent in coastal plain and piedmont. Plants with lemmatal awns 3–10 mm long have been referred to as *M. mexicana* var. *filiformis* (Torr.) Scribn. (Peterson 2003b: 154).

Muhlenbergia racemosa (Michx.) Britton, Sterns, and Poggenb. – Reported from Garrett Co.

Muhlenbergia schreberi J. F.Gmel. – nimblewill. Common weed.

Muhlenbergia sobolifera (Muhl.ex Trin.) Trin. – branched muhly. Frequent, midland and mountain zones.

Muhlenbergia sylvatica (Torr.) Torr.ex A. Gray – woodland muhly. Rare, mostly piedmont.

Muhlenbergia tenuiflora (Willd.) Britton, Sterns, & Poggenb. – slender-flowered muhly. Common in western MD (Frye).

Muhlenbergia torreyana (Schult.) Hitchc. – Rare, Caroline Co. G3.

Muhlenbergia uniflora (Muhl.) Fernald – bog muhly. Prince George's Co., Suitland (Shetler & Stone Orli 2002).

OPLISMENUS P. Beauv.

***Oplismenus hirtellus** (L.) P. Beauv. subsp. **undulatifolius** (Ard.) U. Scholz – Baltimore Co., Patapsco Valley State Park, collected by Edward Uebel in 1996, the first record of this taxon for North America (Peterson et al. 1999). Spreading as noxious weed in 2008–2009.

ORYZOPSIS Michx.

Oryzopsis asperifolia Michx. – Rare, mountains (Frye).

Oryzopsis racemosa (Sm.) Ricker = **Piptatherum racemosum**

PANICUM L.

Some subspecies were treated as varieties in Brown and Brown 1984. M. Lelong determined certain collections.

Panicum agrostoides Spreng. = **P. rigidulum** subsp. **rigidulum**

Panicum amarum Elliott – bitter beachgrass.
- subsp. **amarulum** (Hitchc. & Chase) Freckmann & Lelong – Infrequent in coastal plain.
- subsp. **amarum** – Common in coastal plain.

Panicum anceps Michx. – beaked panicgrass.
- subsp. **anceps** – frequent.
- subsp. **rhizomatum** (Hitchc. & Chase) Freckmann & Lelong – Reported from MD.

Panicum capillare L. subsp. **capillare** – witch grass. Frequent throughout.

Panicum dichotomiflorum Michx. – fall panicum. Common weed.

Panicum flexile (Gatt.) Scribn. – wiry witchgrass. Rare in piedmont.

Panicum gattingeri = **P. philadelphicum** subsp. **gattingeri**

Panicum hemitomon Schult. – maidencane. Infrequent in coastal plain (Frye).

Panicum longifolium Torr. = **P. rigidulum** subsp. **pubescens**

*__Panicum miliaceum__ L. – broom-corn millet, proso millet. Occasionally cultivated and escaped.

*__Panicum paludosum__ Roxb. – Baltimore, chrome ore piles (Reed 1964).

Panicum philadelphicum Bernh. ex Trin. – Philadelphia witchgrass.
  subsp. **philadelphicum**. Rare, Washington-Baltimore area. G3–G5.
  subsp. **gattingeri** (Nash) Freckmann & Lelong – Reported by Kartesz & Meacham (2008).

Panicum psilopodium *Trin.* – Baltimore, chrome ore piles (Reed 1964).

Panicum rigidulum Bosc ex Nees – redtop panicum.
  subsp. **combsii** (Scribn. & C.R. Ball) Freckmann & Lelong – No data on distribution.
  subsp. **elongatum** (Scribn.) Freckmann & Lelong – Piedmont and mountain zones. Prince George's Co., BARC (Terrell et al. 2000).
  subsp. **pubescens** (Vasey) Freckmann & Lelong – Infrequent in piedmont and coastal plain.
  subsp. **rigidulum** (*P. agrostoides*) – Common in piedmont and coastal plain.

Panicum stipitatum Nash = **P. rigidulum** subsp. **elongatum**

*__Panicum sumatrense__ Roth ex Roem & Schult. – Baltimore, chrome ore piles (Reed 1964).

Panicum tuckermanii Fernald = **P. philadelphicum**

Panicum verrucosum Muhl. – warty panicgrass. Frequent throughout.

Panicum virgatum L. – switch grass. Common in coastal plain, rare elsewhere, sometimes cultivated.

PARAPHOLIS C.E. Hubb.

*__Parapholis incurva__ (L.) C.E. Hubb. – curved sickle grass – Baltimore, chrome ore piles (Reed 1964). Calvert Co., Cove Point dunes (Steury 1997). Rarely adventive from Europe.

PASPALUM L.

Paspalum boscianum Flüggé – bull paspalum. Uncommon.

*__Paspalum convexum__ Humb. & Bonpl. ex Flüggé – Baltimore, chrome ore piles (Reed 1964).

*__Paspalum dilatatum__ Poir. – dallis grass. Baltimore Co., Prince George's Co.

Paspalum dissectum (L.) L. – Infrequent in coastal plain.

Paspalum distichum L. – Listed by Guala & Bogler (2004). Data lacking.

Paspalum floridanum Michx. – Florida paspalum. Frequent near and in coastal plain

Paspalum fluitans (Ell.) Kunth = **P. repens**

Paspalum laeve Michx. – smooth paspalum. Common and widespread.

*__Paspalum orbiculatum__ Poir. – Baltimore, chrome ore piles (Reed 1964).

Paspalum pubiflorum Rupr.ex E. Fourn. – Reported from Anne Arundel Co.

Paspalum repens P. J. Bergius – water paspalum. Uncommon.

*__Paspalum scrobiculatum__ L. – Baltimore, chrome ore piles (Reed 1964).

Paspalum setaceum Michx. – slender paspalum. No data for these varieties in Brown & Brown (1984).
  var. **ciliatifolium** (Michx.) Vasey
  var. **muhlenbergii** (Nash) D.J. Banks
  var. **psammophilum** (Nash) D.J. Banks – Occurs in DC.
  var. **setaceum** – Frequent.
  var. **stramineum** (Nash) D.J. Banks

PENNISETUM Rich.

*__Pennisetum glaucum__ (L.) R. Br. – pearl millet. Rarely escaped from cultivation. Anne Arundel, Brooklyn Park (Shetler & Stone Orli 2002). Baltimore, chrome ore piles (Reed 1964).

PHALARIS L.

Phalaris arundinacea L. – reed canary grass. Common in coastal plain and frequent in piedmont and elsewhere.

*__Phalaris canariensis__ L. – canary grass. Baltimore, chrome ore piles (Reed 1964).

Phalaris caroliniana Walter – maygrass. Rare in coastal plain. Baltimore Co., probably extirpated (Shetler & Stone Orli 2002).

Phalaris minor Retz. – Reported by Kartesz & Meacham (2008).

*__Phalaris paradoxa__ L. – Baltimore, chrome ore piles (Reed 1964).

PHLEUM L.

*__Phleum pratense__ L. – timothy. Planted and naturalized. Widespread.

*__Phleum subulatum__ (Savi) Asch. & Graebn. – Baltimore, chrome ore piles (Reed 1964).

PHRAGMITES Adans. Reed.

Phragmites australis (Cav.) Trin. ex Steud. – common reed. Common and widespread. Two lineages are recognized in Maryland by Saltonstall et al. (2004), *P. australis* subsp. *americanus* Saltonstall, P.M. Peterson, & Soreng, the native lineage and an unnamed introduced lineage.

Phragmites communis Trin. = **P. australis**

PHYLLOSTACHYS Siebold & Zucc.

*__Phyllostachys aurea__ Carrière ex Rivière & C. Rivière – Listed by Guala & Bogler (2004).

*__Phyllostachys bambusoides__ Siebold & Zucc. – Cultivated and sometimes spreading. Hyattsville, Prince George's Co.

*__Phyllostachys flexuosa__ Rivière & C. Rivière – Cultivated and sometimes spreading. Frederick Co.

PIPTATHERUM P. Beauv.

*__Piptatherum miliaceum__ (L.) Coss. – Baltimore, pumice piles (Reed 1964).

Piptatherum racemosum (Sm.) Eaton – mountain ricegrass. (*Oryzopsis racemosa* (Sm.) Ricker). Rare, mountain zone and Washington Co. Three MD collections at MARY.

PIPTOCHAETIUM J. Presl

Piptochaetium avenaceum (L.) Parodi – blackseed speargrass. (*Stipa avenacea* L.). Coastal plain. Montgomery Co. (seen by Terrell along C. & O. canal). MARY has vouchers from Anne Arundel, Caroline, Howard, and Prince George's cos.

POA L. Bluegrass.

Poa alsodes A. Gray – Uncommon, Garrett and Allegany cos. G4–G5.

***Poa annua** L. – annual bluegrass. Common and widespread.

Poa autumnalis Muhl. ex Elliott – autumn bluegrass. Infrequent piedmont and coastal plain.

***Poa bulbosa** L. – Infrequent. Montgomery Co., seen by R.J. Soreng and P. Peterson,

Poa chapmaniana Scribn. – Uncommon. Reported by Kartesz & Meacham (2008).

***Poa compressa** L. – Canada bluegrass. Common and widespread.

Poa cuspidata Nutt. – short-leaved bluegrass. Common throughout (Frye).

***Poa nemoralis** L. – woods bluegrass. Prince George's (Shetler & Stone Orli 2002) and Montgomery cos. (R.J. Soreng, pers. comm.).

***Poa palustris** L. – fowl meadow grass. Infrequent in Howard and Washington cos. and DC area.

***Poa pratensis** L
- subsp. **angustifolia** (L.) Lej. – narrow-leaved Kentucky bluegrass. Prince Georges Co., BARC (det. by R.J. Soreng), Montgomery Co. (R.J. Soreng collection).
- subsp. **pratensis**. – Kentucky bluegrass. Very common and widespread.

Poa saltuensis Fernald & Wiegand
- subsp. **languida** (Hitchc.) A. Haines. Mountains. No data. G3–G4.
- subsp. **saltuensis** – Rare, western MD. Garrett Co. collection at TAWES (Frye).

Poa sylvestris A. Gray – sylvan bluegrass. Frequent in piedmont and mountains, rare on coastal plain.

***Poa trivialis** L. – rough-stemmed bluegrass. Common and invasive, piedmont and northern coastal plain.

POLYPOGON Desf.

***Polypogon monspeliensis** (L.) Desf. – rabbitsfoot grass. Frequent in coastal plain. St. Mary's Co., Point Lookout (Shetler & Stone Orli 2002).

PSEUDOSASA Makino ex Nakai

***Pseudosasa japonica** (Siebold & Zucc.) Makino – cultivated and sometimes spreading. DC area.

PUCCINELLIA Parl. Alkali Grass.

***Puccinellia distans** (L.) Parl. – rare to infrequent in coastal plain. Baltimore Co. (Shetler & Stone Orli 2002).

Puccinellia fasciculata (Torr.) Bickn. – Coastal plain.

Puccinellia pallida (Torr.) Clausen = **Torreyochloa pallida**

(*RHYNCHELYTRUM* Nees)

Rhynchelytrum repens (Willd.) C.E. Hubb. = **Melinus repens**

ROSTRARIA Trin.

***Rostraria cristata** (L.) Tzvelev – annual June grass. [*Koeleria phleoides* (Vill.) Pers.]. Baltimore, chrome ore piles (Reed 1964).

SACCHARUM L. Plumegrass. (These species formerly in *Erianthus*).

Saccharum alopecuroides (L.) Nutt. – silver plumegrass. Rare in coastal plain. Calvert Co., Cove Point (Steury 2002).

Saccharum baldwinii Spreng. – Rare. Reported by Kartesz & Meacham (2008).

Saccharum brevibarbe (Michx.) Pers. – shortbeard plumegrass.
- var. **brevibarbe** – Somerset Co.
- var. **contortum** (Baldwin) R.D. Webster – Common in coastal plain.

Saccharum coarctatum (Fernald) R.D. Webster – compressed plumegrass. Frequent, coastal plain (Frye). Listed in Brown & Brown (1984) without locations.

Saccharum giganteum (Walter) Pers. – sugarcane plumegrass. Common in coastal plain.

***Saccharum ravennae** (L.) L. – ravenna grass. Cultivated and sometimes escaped to roadsides.

SACCIOLEPIS Nash

Sacciolepis striata (L.) Nash – American cupscale. Rare, coastal plain. Calvert Co. (Shetler & Stone Orli 2002). Worcester Co.: Assateague Island, Aug 1984, *Hill 15576* (MARY, US); Shad Landing State Park, Sep 2005, *Terrell 6311* (US).

SCHEDONORUS P. Beauv.

***Schedonorus arundinaceus** (Schreb.) Dumort. – tall fescue (*Festuca arundinacea* Schreb.). Planted on roadsides and elsewhere; an abundant weed.

***Schedonorus pratensis** (Huds.) P. Beauv. – meadow fescue (*Festuca pratensis* Huds.). Occasional weed and presumably planted. Believed to be much less frequent than formerly.

SCHIZACHNE Hack.

Schizachne purpurascens (Torr.) Swallen – false melic. Rare, mountain zone. Cited as occurring in MD (Cayouette & Darbyshire 2007: 103). Garrett Co., Jun 1940, *Kearney, Norton et al. s.n.* (MARY, US).

SCHIZACHYRIUM Nees

Schizachyrum littorale (Nash) E.P.Bicknell – Reported in Brown & Brown (1984). MARY voucher reported by Kartesz & Meacham (2008).

Schizachyrum scoparium (Michx.) Nash – little bluestem. (*Andropogon scoparius* Michx.). Throughout MD, common in coastal plain.

SCLEROCHLOA P. Beauv.

Sclerochloa dura (L.) P. Beauv. – Frederick Co., cornfield, Hill in 1988 (Shetler & Stone Orli 2002). Frederick Co., location unknown, sent in by Cooperative Extension Service, 8 May 1986 (MARY); Howard Co., *Soreng 5929b* (US).

SECALE L. Rye.

***Secale cereale** L. – rye. Cultivated and occasionally escaped.

SETARIA P. Beauv. Foxtail, Bristlegrass.

***Setaria faberi** R.A.W. Herrm. – nodding foxtail. Common throughout.

Setaria geniculata (Lam.) P. Beauv. = **S. parviflora**

Setaria glauca (L.) P. Beauv. = **Pennisetum glaucum**. Yellow foxtail was formerly widely known as *Setaria glauca*; see *S. pumila*.

Setaria grisebachii E. Fourn. – Baltimore, chrome ore piles (Reed 1964).

***Setaria italica** (L.) P. Beauv. – foxtail millet. Cultivated and escaped to roadsides.

Setaria magna Griseb. – giant foxtail, saltmarsh foxtail. Infrequent in coastal plain. Blackwater Refuge, Dorchester Co. (seen by Terrell).

Setaria parviflora (Poir.) Kerguélen – knotroot foxtail. Infrequent in coastal plain. Prince George's Co., BARC (Terrell et al. 2000).

***Setaria pumila** (Poir.) Roem. & Schult. – yellow foxtail. Common throughout.

***Setaria verticillata** (L.) P. Beauv. – hooked bristlegrass. Infrequent throughout.

***Setaria verticilliformis** Dumort. – Reported by Kartesz & Meacham (2008).

***Setaria viridis** (L.) P. Beauv. – green foxtail, green bristlegrass. Common throughout.

SORGHASTRUM Nash. Indian Grass.

Sorghastrum elliottii (C. Mohr) Nash – long-bristled Indian grass. Rare, coastal plain. Wicomico, Dorchester, and Worcester cos. (Frye).

Sorghastrum nutans (L.) Nash – Indian grass. Common throughout MD.

SORGHUM Adans. Sorghum.

***Sorghum bicolor** (L.) Moench – sorghum. Cultivated and occasionally escaped.

***Sorghum halepense** (L.) Pers. – Johnson grass. Common and widespread weed.

SPARTINA Schreb. Cordgrass.

Spartina alterniflora Loisel – smooth cordgrass. Common on coastal plain.

Spartina ×caespitosis A. A. Eaton – tufted cordgrass. Putative cross of *S. patens* and *S pectinata*. Calvert Co (Shetler & Stone Orli 2002).

Spartina cynosuroides (L.) Roth – big cordgrass. Common on coastal plain.

Spartina patens (Aiton) Muhl. – salt-meadow cordgrass. Common on coastal plain.

Spartina pectinata Link – prairie cordgrass. Infrequent in a variety of habitats.

SPHENOPHOLIS Scribn. Wedgegrass.

Sphenopholis intermedia (Rydb.) Rydb. – slender wedgegrass. Rather widespread.

Sphenopholis nitida (Biehler) Scribn. – Frequent throughout.

Sphenopholis obtusata (Michx.) Scribn. – prairie wedgegrass. Rather widespread.

Sphenopholis ×pallens (Biehler) Scribn. = **S. obtusata** × **S. pensylvanica** as reported from MARY by Kartesz & Meacham (2008).

Sphenopholis pensylvanica (L.) Hitchc. – swamp wedgegrass. (*Trisetum pensylvanicum* (L.) P. Beauv. ex Roem. & Schult.). Infrequent in piedmont and coastal plain. Finot et al. (2005) also placed this species in **Sphenopholis**. G4.

SPOROBOLUS R. Br. Dropseed.

Sporobolus asper (P. Beauv.) Kunth = **S. compositus**

Sporobolus clandestinus (Biehler) Hitchc. – Rare, eastern MD.

Sporobolus compositus (Poir.) Merr. – Reported from Queen Anne and Talbot cos. as S. asper in Brown & Brown (1984).

***Sporobolus coromandelianus** (Retz.) Kunth – Baltimore: chrome ore piles (Reed 1964).

Sporobolus heterolepis (A. Gray) A. Gray – Rare in piedmont. Reported by Kartesz & Meacham (2008).

***Sporobolus indicus** (L.) R. Br. – smut grass. Calvert Co., Cove Point Park, Steury (2000); Worcester Co., two collections as roadside weed, 7 mi ENE of Pocomoke City and Assateague Island, Terrell 6309 and 6314 (MARY). Probably frequent on coastal plain.

Sporobolus neglectus Nash – Reported as extirpated from MD (Peterson et al. 2003: 121). Frye reports a collection in Baltimore County.

***Sporobolus pyramidatus** (Lam.) Hitchc. – Baltimore, chrome ore piles (Reed 1964). Prince George's Co., near Laurel, as an abundant roadside weed, Terrell 6286, in 2005; det. by P. M. Peterson). A southern and southwestern species.

Sporobolus vaginiflorus (Torr. ex A. Gray) Alph.Wood – poverty dropseed. Frequent weed.

Sporobolus virginicus (L.) Kunth – seashore dropseed. Baltimore, manganese ore piles (Reed 1964).

STIPA L. Needle grass.

Stipa avenacea L. = **Piptochaetium avenaceum**

THEMEDA Forssk.

***Themeda arguens** (L.) Hack. – Baltimore, chrome ore piles (Reed 1964).

TORREYOCHLOA G.L. Church

Torreyochloa pallida (Torr.) G.L.Church – Frequent in coastal plain. [*Puccinellia pallida* (Torr.) Clausen].

TRAGUS Haller

***Tragus racemosus** (L.) All. – Baltimore, chrome ore piles (Reed 1964).

TRIDENS Roem. & Schult.

Tridens flavus (L.) Hitchc. – purpletop. See key to separate the vars. in Valdés Reyna (2003:39).

var. **chapmanii** (Small) Shinners – Reported by Kartesz & Meacham (2008).

var. **flavus** – Common and widespread.

(*TRIODIA* R. Br.) = **Tridens**

TRIPLASIS P. Beauv. Sand Grass.

Triplasis purpurea (Walter) Chapm. – purple sandgrass. Frequent in coastal plain.

TRIPSACUM L. Gama Grass.

Tripsacum dactyloides (L.) L. – eastern gama grass. Frequent.

TRISETUM L.

Trisetum pensylvanicum (L.) P. Beauv. = **Sphenopholis pensylvanica** (L.) Hitchc.

TRITICUM L. Wheat.

***Triticum aestivum** L. – wheat. Rarely escaped from cultivation.

UNIOLA L.

Uniola latifolia Michx. = **Chasmanthium latifolium**

Uniola laxa (L.) BSP = **Chasmanthium laxum**

Uniola paniculata L. – sea oats. Planted on beaches as erosion preventive. Common in southeastern U.S.

UROCHLOA P. Beauv.

***Urochloa distachya** (L.) T.Q. Nguyen – Reported by Kartesz & Meacham (2008).

***Urochloa mutica** (Forssk.) T.Q. Nguyen – (*Brachiaria mutica* (Forssk.) Stapf). Baltimore, chrome ore piles, reported as *Panicum purpurascens* (Reed 1964; Shetler & Stone Orli 2002).

***Urochloa panicoides** P. Beauv. Baltimore, chrome ore piles (Reed 1964).

***Urochloa plantaginea** (Link) R.D. Webster – plantain signalgrass. [*Brachiaria plantaginea* (Link) Hitchc.]. Wicomico Co. (Terrell & Reveal 1996).

***Urochloa platyphylla** (Munro ex C. Wright) R.D. Webster – broadleaf signalgrass. (*Brachiaria platyphylla* Munro ex C. Wright). Wicomico and Somerset cos. (Terrell & Reveal 1996).

***Urochloa ramosa** (L.) T.Q. Nguyen – Baltimore, chrome ore piles, reported as *Panicum ramosum* (Reed 1964; Shetler & Stone Orli 2002).

***Urochloa reptans** (L.) Stapf – Baltimore, chrome ore piles, reported as *Panicum reptans* (Reed 1964; Shetler & Stone Orli 2002).

***Urochloa texana** (Buckley) R.D. Webster – Texas signalgrass. [*Brachiaria texana* (Buckley) S.T. Blake]. Dorchester and Wicomico cos. (Terrell & Reveal 1996).

***Urochloa villosa** (Lam.) T.Q.Nguyen – Reported by Kartesz & Meacham (2008).

VULPIA C.C.Gmel.

Vulpia elliotea (Raf.) Fernald = **V. sciurea**

***Vulpia myuros** (L.) C.C. Gmel. – rat-tail fescue. Common.

Vulpia octoflora (Walter) Rydb. – six-weeks fescue. Common.

Vulpia sciurea (Nutt.) Henrard – squirrel-tail fescue. Frequent on coastal plain. Montgomery and Prince George's cos. (Shetler & Stone Orli 2002); Calvert Co., Cove Point (Steury 1997).

ZEA L.

***Zea mays** L. – corn, maize. Rarely escapes from cultivation.

ZIZANIA L. Wild-rice.

Zizania aquatica L. – southern wild-rice. Frequent in coastal plain.

Zizania palustris L. Reported by Guala & Bolger (2004) but occurs only north and west of MD (Terrell 2003: 48; Terrell et al. 1997).

ZIZANIOPSIS Doell & Aschers.

Zizaniopsis miliacea (Michx.) Doell. & Aschers. – giant cutgrass. Rare in coastal plain. Calvert Co., Cove Point (Steury 1997).

ZOYSIA Willd.

***Zoysia japonica** Steud. – zoysia. Lawn grass, sometimes spreading.

ACKNOWLEDGMENTS

We are grateful to Christopher Frye for his review which added a number of additional records based on his extensive knowledge of the Maryland flora. We thank Robert J. Soreng for information on *Diarrhena* and *Poa*, and for suggestions regarding the format of the list. An anonymous reviewer contributed helpful suggestions.

REFERENCES

Allred, K.W. and M.E. Barkworth. 2007. 14.60 *Anthoxanthum* L. In: Barkworth, M.E., K.M. Capels, S. Long, L.K. Anderton, and M.B. Piep, eds. Magnoliophyta: Commelinidae (in part): Poaceae, part 1. Flora of North America North of Mexico, volume 24. Oxford University Press, New York. Pp. 758–764.

Barkworth, M.E., K.M. Capels, S. Long, and M.B. Peip. 2003. Magnoliophyta: Commelinidae (in part): Poaceae, part 2. Flora of North America North of Mexico, volume 25. Oxford University Press, New York.

Barkworth, M.E., K.M. Capels, S. Long, L.K. Anderton, and M.B. Peip. 2007. Magnoliophyta: Commelinidae (in part): Poaceae, part 1. Flora of North America North of Mexico, volume 24. Oxford University Press, New York.

Brandenburg, D.M. 2007. 8.01 *Diarrhena* P. Beauv. In: Barkworth, M. E., K. M. Capels, S. Long, L.K. Anderton, and M. B. Piep, eds. Magnoliophyta: Commelinidae (in part): Poaceae, part 1. Flora of North America North of Mexico, volume 24. Oxford University Press, New York. Pp. 64–66.

Brown, M.L. and R.G. Brown. 1984. Herbaceous plants of Maryland. The Book Center, University of Maryland, College Park. Port City Press, Inc., Baltimore, Maryland.

Cayouette, J. and S.J. Darbyshire. 2007. 9.03 *Schizachne* Hack. In: Barkworth, M.E., K.M. Capels, S. Long, L.K. Anderton, and M.B. Piep, eds. Magnoliophyta: Commelinidae (in part): Poaceae, part 1. Flora of North America North of Mexico, volume 24. Oxford University Press, New York. Pp. 103–104.

Fernald, M.L. 1950. Gray's manual of botany. Ed 8. American Book Co., New York.

Finot, V.L., P.M. Peterson, R.J. Soreng, and F.O. Zuloaga. 2005. A revision of *Trisetum* and *Graphephorum* (Poaceae: Aveninae) in North America north of Mexico. Sida 21:1419–1453.

Fleming, P. and R. Canal. 1995. Annotated checklist of vascular plants of Rock Creek Park, National Park Service, Washington D.C. Castanea 60:283–316.

Gleason, H.A. and A. Cronquist. 1991. Manual of vascular plants of northeastern United States and adjacent Canada. New York Botanical Garden, New York.

Grass Phylogeny Working Group. 2001. Phylogeny and subfamilial classification of the grasses (Poaceae). Ann. Missouri Bot. Gard. 88:373–457.

Guala, G.F. and D. Bogler. 2004. SLIKS. United States Department of Agriculture, NRCS, NPDC. Grasses of Maryland.

Harvill, A.M., Jr., T.R. Bradley, C.E. Stevens, T.F. Wieboldt, D.M.E. Ware, D.W. Ogle, G.W. Ramsey, and G.P. Fleming. 1992. Atlas of the Virginia flora III. Virginia Botanical Associates, Burkeville, Virginia.

Hermann, F.J. 1946. A checklist of plants in the Washington-Baltimore area. Ed. 2. Conference on District Flora, Smithsonian Institution, Washington, DC. Duplicated.

Hitchcock, A.S. and P.C. Standley. 1919. Flora of the District of Columbia and vicinity. Contr. U.S. Natl. Herb. 21:1–329.

Kartesz, J.T. and C.A. Meacham. 2008. Floristic synthesis of North American (Draft) version Feb 2008.

Marr, K.L, R.J. Hebda, and C.W. Greene. 2007. 14.49 *Calamagrostis* Adans. In: Barkworth, M.E., K.M. Capels, S. Long, L.K. Anderton, and M.B. Piep, eds. Magnoliophyta: Commelinidae (in part): Poaceae, part 1. Flora of North America North of Mexico, volume 24. Oxford University Press, New York. Pp. 706–7732.

Maryland Department of Natural Resources. 2007. Rare, threatened, and endangered plants of Maryland. 13 November. Annapolis, Maryland.

Norton, J.B.S. 1930. Maryland grasses. Maryland Agric. Exp. Sta. Bull. 323:215–326.

Peterson, P.M. 2003*a*. *17.23 Eragrostis* Wolf. In: Barkworth, M.E., K.M. Capels, S. Long, and M.B. Piep, eds. Magnoliophyta: Commelinidae (in part): Poaceae, part 2. Flora of North America North of Mexico, volume 25. Oxford University Press, New York. Pp. 65–105.

Peterson, P.M. 2003b. *17.33 Muhlenbergia* Schreb. In: Barkworth, M.E., K.M. Capels, S. Long, and M.B. Piep, eds. Magnoliophyta: Commelinidae (in part): Poaceae, part 2. Flora of North America North of Mexico, volume 25. Oxford University Press, New York. Pp. 145–201.

Peterson, P.M., S.L. Hatch, and A.S. Weakley. 2003. 17.30 *Sporobolus* R. Br. In: Barkworth, M.E., K.M. Capels, S. Long, and M.B. Piep, eds. Magnoliophyta: Commelinidae (in part): Poaceae, part 2. Flora of North America North of Mexico, volume 25. Oxford University Press, New York. Pp. 115–139.

Peterson, P.M., E.E. Terrell, E.C. Uebel, C.A. Davis, H. Scholz, and R.J. Soreng. 1999. *Oplismenus hirtellus* subspecies *undulatifolius*, a new record for North America. Castanea 64:201–202.

Reed, C.F. 1964. A flora of the chrome and manganese ore piles at Canton in the port of Baltimore, Maryland, and at Newport News, Virginia, with descriptions of the genera and species new to the flora of the eastern United States. Phytologia 10:324–406.

Reed, C.F. 1986. Floras of the serpentinite formations in eastern North America: with descriptions of geomorphology and mineralogy of the formations. Contr. Reed Herb. (USA) 30:1–858.

Saarela, J.M., P.M. Peterson, R.J. Soreng, and R.E. Chapman. 2003. A taxonomic revision of the Eastern North American and Eastern Asian disjunct genus *Brachyelytrum* (Poaceae): evidence from morphology, phytogeography and AFLPs. Syst. Bot. 28:674–692.

Saltonstall, K., P.M. Peterson, and R.J. Soreng. 2004. Recognition of *Phragmites australis* subsp. *americanus* (Poaceae: Arundinoideae) in North America: evidence from morphological and genetic analyses. Sida 21:683–692.

Shetler, S.G. and S. Stone Orli. 2002. Annotated checklist of the vascular plants of the Washington-Baltimore Area.

Part II. Monocotyledons. Botany Section, Department of Systematic Biology, National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Soreng, R.J., G. Davidse, P.M. Peterson, F.O. Zuloaga, E.J. Judziewicz, T.S. Filgueiras, and O. Morrone. 2009. Catalogue of New World grasses. Suprageneric classification. http://mobot.mobot.org/W3T/Search/nwgclass.html.

Steury, B.W. 1997. Survey for endangered, threatened, and rare vascular plants in Cove Point Marsh, Maryland. The Maryland Naturalist 41:89–96.

Steury, B.W. 1999. Annotated list of vascular plants from a nontidal barrier wetland along the Chesapeake Bay in Calvert Co., Maryland. Castanea 64:187–200.

Steury, B.W. 2000. Noteworthy collection, Maryland. Castanea 65:168.

Steury, B.W. 2002. The vascular flora of Cove Point, Calvert Co., Maryland. Maryland Naturalist 45:31–57.

Terrell, E.E. 2003. 5.04 *Zizania* L. In: Barkworth, M.E., K.M. Capels, S. Long, L.K. Anderton, and M.B. Piep, eds. Magnoliophyta: Commelinidae (in part): Poaceae, part 1. Flora of North America North of Mexico, volume 24. Oxford University Press, New York. Pp. 47–51.

Terrell, E.E., P.M. Peterson, J.L. Reveal, and M.R. Duvall. 1997. Taxonomy of North American species of *Zizania* (Poaceae). Sida 17:533–549.

Terrell, E.E. and J.L. Reveal. 1996. Noteworthy collections, Maryland. Castanea 61:95–97.

Terrell, E.E., J.L. Reveal, R.W. Spjut, R.F. Whitcomb, J.H. Kirkbride, Jr., M.T. Cimino, and M. Strong. 2000. Annotated list of the Flora of the Beltsville Agricultural Research Center, Beltsville, Maryland. U.S. Department of Agriculture, Agricultural Research Service (ARS) 155:1–89.

Valdes Reyna, J. 2003. 17.10. *Tridens* Roem. & Schult. In: Barkworth, M.E., K.M.Capels, S. Long, and M.B. Piep, eds. Magnoliophyta: Commelinidae (in part): Poaceae, part 2. Flora of North America north of Mexico, volume 25. Oxford University Press, New York. Pp. 33–40.

Veldkamp, J.F. 2004. Miscellaneous notes on mainly southeast Asian Gramineae. Reinwardtia 12:135–140.

Watson, L. and M.J. Dallwitz. 1992. The grass genera of the World. University Press, Cambridge.

Watson, L. and M.J. Dallwitz. 1999. Grass genera of the World: descriptions, identification, and information retrieval; including synonyms, morphology, anatomy, physiology, phytochemistry, cytology, classification, pathogens, World and local distribution, and references. http://biodiversity.uno.edu/delta/.

Zizka, G. 1988. Revision de Melinideae Hitchcock (Poaceae, Panicoideae). Biblioth. Bot. 138:1–149.

BOOK NOTICE

Stephen Shennan (eds). 2009. **Pattern and Process in Cultural Evolution.** (ISBN 978-0-520-25599-9, hbk.). University of California Press, 2120 Berkeley Way, Berkeley, California 94704-1012, U.S.A. (**Orders:** www.ucpress.edu or California-Princeton Fulfillment Services, 1445 Lower Ferry Road, Ewing, New Jersey 08618, U.S.A., orders@cpfsinc.com, 1-800-777-4726). $60.00, 341 pp., b&w photographs, line drawings, maps, tables, 7" × 10".

Contents:

Acknowledgments
1. Pattern and Process in Cultural Evolution: An Introduction—*Stephen Shennan*

I. UNDERSTANDING CULTURAL TRANSMISSION

2. Placing Archaeology within a Unified Science of Cultural Evolution—*Alex Mesoudi & Michael J. O'Brien*
3. Human Communication as Niche Construction—*Robert Aunger*
4. Modes of Transmission and Material Culture Patterns in Craft Skills—*Robert Hosfield*
5. Linking Pattern to Process in Cultural Evolution: Investigating Material Culture Diversity Amount Northern Khanty of Northwest Siberia—*Peter Jordan*
6. Tangled Trees: Modeling Material Culture Evolution as Host-Associate Cospeciation—*Felix Riede*
7. The Evolution of Material Culture Diversity Among Iranian Tribal Populations—*Jamshid J. Tehrani & Mark Collard*
8. Evolutionary Explanation and the Record of Interest: Using Evolutionary Archaeology and Dual Inheritance Theory to Explain the Archaeological Record—*Ethan E. Cochrane*
9. Identifying Iron Production Lineages: A Case Study in Northwest Wales—*Michael F. Charlton*

II. TESTING EVOLUTIONARY HYPOTHESES

10. Quantitative Analysis of Macroevolutionary Patterning in Technological Evolution: Bicycle Design from 1800 to 2000—*Mark W. Lake & Jay Venti*
11. Innovation Diffusion and Traveling Waves—*James Steele*
12. Explaining Global Patterns in Lower Paleolithic Technology: Simulations of Hominin Dispersal and Cultural Transmission Using Stepping Out—*Sam Smith, John Hughes, & Steven Mithen*
13. Population History and the Evolution of Mesolithic Arrowhead Technology in South Scandinavia—*Kevan Edinborough*
14. Experimentation and Innovation in the Archaeological Record: A Case Study in Technological Evolution from Kodiak, Alaska—*Ben Fitzhugh & A. Kate Trusler*

III. SOCIAL EVOLUTION

15. Mind the Bonding Gap: Constraints on the Evolution of Hominin Societies—*R.I.M. Dunbar*
16. Testing Functional Hypotheses About Cross-Cultural Variation: A Maximum-Likelihood Comparative Analysis of Indo-European Marriage Practices—*Laura Fortunato & Ruth Mace*
17. Parent-Offspring Conflict in Marriage: Implications for Social Evolution and Material Culture Among the Ju/'Hoansi Bushmen—*Polly Wiessner*
18. Prestige Goods and the Formation of Political Hierarchy: A Costly Signaling Model—*Aimée M. Plourde*
19. Population and Warfare: A Test of the Turchin Model in Pueblo Societies—*Timothy A. Kohler, Sarah Cole, & Stanca Ciupe*
20. An Ecological Model for the Emergence of Institutionalized Social Hierarchies on California's Northern Channel Islands—*Douglas J. Kennett, Bruce Winterhalder, Jacob Bartruff, & Jon M. Erlandson*
21. Population, Sociopolitical Simplification, and Cultural Evolution of Levantine Neolithic Villages—*Ian Kuijt*

List of Contributors
Index

J. Bot. Res. Inst. Texas 3(2): 920. 2009

FLORISTIC STUDIES IN NORTH CENTRAL NEW MEXICO, U.S.A. THE TUSAS MOUNTAINS AND THE JEMEZ MOUNTAINS

Brian Reif

Northern Arizona University
P.O. Box 15018
Flagstaff, Arizona 86001, U.S.A.
brian.reif@nau.edu

Jill Larson

Black Hills National Forest
2014 North Main St.
Spearfish, South Dakota 57783, U.S.A.
jilllarson@fs.fed.us

Brian F. Jacobs

Bandelier National Monument
Los Alamos, New Mexico 87544, U.S.A.
brian_jacobs @nps.gov

B.E. Nelson and Ronald L. Hartman

Rocky Mountain Herbarium
Department of Botany, Dept. 3165
University of Wyoming
1000 E. University Ave.
Laramie, Wyoming 82071, U.S.A.
bnelsonn or rhartman@uwyo.edu

ABSTRACT

This paper represents the first of two contributions that cover the floristic diversity in north central New Mexico. The area encompasses the Tusas Mountains and the Jemez Mountains (including Sierra Nacimiento) of the Carson National Forest and Santa Fe National Forest. Also included is Bandelier National Monument, Valles Caldera National Preserve, Bureau of Land Management (Taos District), and other federal, state, and private lands west of the Rio Grande. The second paper will discuss the floristics of the portions of the two forests and periphery to the east of the Rio Grande, thus primarily the Sangre de Cristo Range. The goal of this two-part series is to enumerate results of the most intensive floristic inventory ever conducted in New Mexico. Here, we report on 19,929 numbered collections of vascular plants (the sum for the entire area covering more than 3.7 million acres is 35,857 new collections). A total of 1,384 unique taxa, including 93 infraspecics and 10 hybrids, are documented from 107 families. Of these, 154 are exotics (14 are designated as noxious in New Mexico), 22 are species of conservation concern, 28 represent first reports or their confirmation for New Mexico, and finally 17 are endemics to New Mexico. Based on verified material at four herbaria, 64 additional unique taxa are included in the Annotated Checklist; thus the grand total is 1,445.

RESUMEN

Este artículo es la primera de dos contribuciones que cubren la diversidad florística en el norte-centro de Nuevo México. Este área rodea las Montañas Tusas y las Montañas Jemez (incluyendo la Sierra Nacimiento) del Carson National Forest y Santa Fe National Forest. También están incluidos el Bandelier National Monument, la Valles Caldera National Preserve, Bureau of Land Management (Distrito de Taos), y otras tierras federales, estatales y privadas al oeste del Río Grande. El segundo artículo discutirá la florística de las porciones de los dos bosques y periferia al este del Río Grande. Primariamente la Cordillera Sangre de Cristo. El objetivo de esta serie de dos partes es enumerar los resultados del mayor inventario florístico intensivo llevado a cabo en Nuevo México. Aquí, citamos 19,929 colecciones numeradas de plantas vasculares (la suma para el área completa que cubre más de 3.7 millones de acres es de 35,857 nuevas colecciones). Se documentan un total de 1,384 taxa únicos, que incluyen 93 infraespecíficos y 10 híbridos, de 107 familias. De estas, 154 son exóticas (14 se designan como nocivas en Nuevo México), 22 son especies con preocupación en su conservación, 28 representan primeras citas o su confirmación para Nuevo México, y finalmente 17 son endémicas de Nuevo México. Basados en material verificado en cuatro herbarios, se incluyen 64 taxa adicionales únicos en el catálogo comentado; llegando así a un total de 1,445.

INTRODUCTION

We report on botanical inventories in the western portions of the Carson National Forest (CNF) and the Santa Fe National Forest (SFNF) by Jill Larson (2008) and Brian Reif (2006), respectively. Included are surrounding public lands administered by the State of New Mexico as well as the Bureau of Land Management, and some private lands (Fig. 1). These segments of the two Forests are defined as the portions occurring west of the Rio Grande. Thus they include the Tusas Mountains to the north and the Jemez Mountains and Sierra Nacimiento to the south. Results of two additional studies in the Jemez Mountains are included:

J. Bot. Res. Inst. Texas 3(2): 921 – 961. 2009

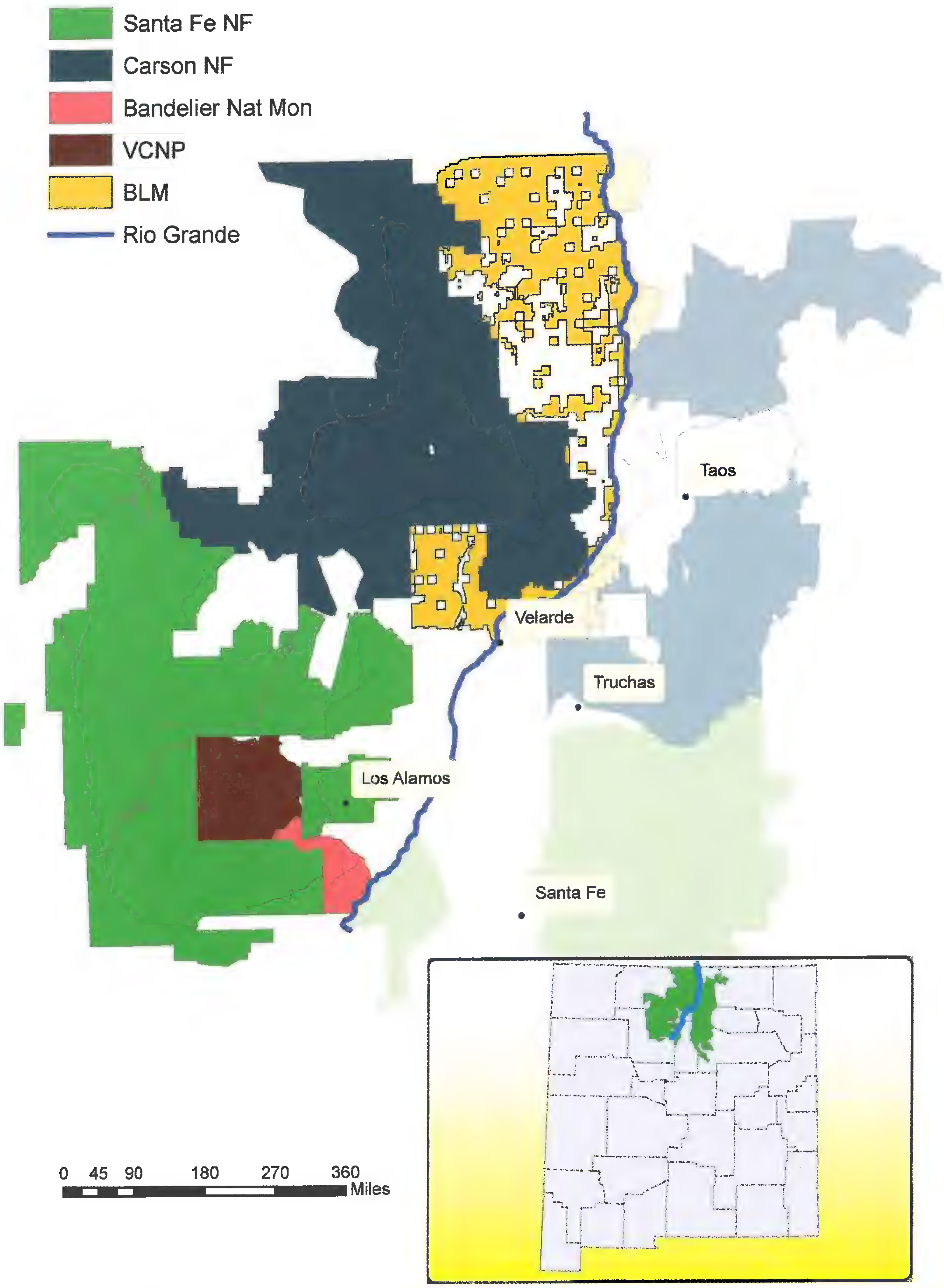

Santa Fe NF
Carson NF
Bandelier Nat Mon
VCNP
BLM
Rio Grande
Taos
Velarde
Truchas
Los Alamos
Santa Fe
0 45 90 180 270 360
Miles

Fig. 1. Location of the entire study area in north central New Mexico. This paper discusses floristic research conducted in the portion to the west of the Rio Grande. Lands to the east of the River (in more muted colors) will be treated in a companion paper. The location of major towns and villages are indicated and federal agency lands are delineated (see coding, upper left corner of plate).

Bandelier National Monument (BNM; Jacobs 1989) and the Valles Caldera National Preserve (VCNP). Data from the latter, although reported separately (Hartman & Nelson 2005), were incorporated into the SFNF thesis (Reif 2006).

This is the first of two papers on federal and adjoining lands in north central New Mexico. The second will focus on the Sangre de Cristo Mountains to the east of the Rio Grande (largely CNF and SFNF). The Jicarilla Ranger District of the Carson National Forest in northwestern Rio Arriba County is excluded, although inventoried by Larson (2008).

The geographic area covered in this paper is over 2.4 million acres (the area as a whole inventoried in the two thesis projects and BNM was over 3.7 million acres). Included are all of Los Alamos, eastern Rio Arriba excluding the extreme southeast corner, northeastern Sandoval, northwest Santa Fe, and western Taos counties. Data on the Tusas Mountains are limited to the portion under the jurisdiction of the Carson National Forest (see Heil & O'Kane 2007 for partial coverage of the western slope). The area ranges in elevation from about 5,500 feet to just over 10,900 feet.

These botanical inventories are part of the larger effort by the Rocky Mountain Herbarium (RM) to produce a critical flora of the Rocky Mountains and to map, based on vouchered specimens, the distributions of its taxa in relatively fine detail (Hartman 1992; Hartman & Nelson 2008; Hartman et al. 2009). To this end, over 64 major floristic inventories have been conducted since 1978 from Oregon, Washington, Idaho, Montana, and South Dakota south to north central New Mexico. Over 575,000 new numbered collections have been obtained. They form the core of the 700,000 record Rocky Mountain Herbarium plant specimen database (Hartman et al. 2009).

Topography.—A majority of the area is within the Southern Rocky Mountain Region (Fenneman 1931). To the north, in southern Colorado, this region is divided by the headwaters of the Rio Grande, thus forming the broad, treeless San Luis Valley. Here the San Juan Mountains are to the west and the Sangre de Cristo Mountains are to the east. This division extends into New Mexico (the CNF), where the San Juan Mountains that extend southeast from Colorado are known locally as the Tusas Mountains. The San Juan or Tusas Mountains are separated to the south from the Jemez Mountains and the Sierra Nacimiento by the Rio Chama (Fenneman 1931). The surficial geology is largely volcanic. On the east side of the Rio Grande, the Sangre de Cristo Mountains form the southernmost range of the Rockies. At the southern terminus, near Santa Fe, they dissolve into a landscape of mesas and plains.

Unless stated to the contrary, the following discussion is limited to the Tusas Mountains, Jemez Mountains, Sierra Nacimiento, and vicinity. The region may be divided broadly into three geomorphic units: the Rio Grande Rift (including Taos Plateau), the Tusas Mountains, and the Jemez Mountains (including the Sierra Nacimiento).

The Taos Plateau is a broad basin and the southern extension of the San Luis Valley of Colorado in the northern portion of the valley of the Rio Grande. It is peppered with volcanic cones some of which rise 3,000 feet or more above the surrounding desert grass- and shrublands. The Rio Grande has cut a deep, narrow canyon through the basin and in places the gorge exceeds 800 feet in depth. To the south, the Rio Grande Rift is the portion constricted by mountains and formed by the Embudo Fault (Muehlberger 1978; Muehlberger & Muehlberger 1982).

To the west, the Tusas Mountain unit consists of low mountains and expansive valleys, descending south to the Rio Chama. Thus, a portion of the southern Chama Basin is included. The highest point in the Tusas Mountains under jurisdiction of the CNF is Canjilon Mountain at 10,903 feet.

To the south of the Rio Chama lies the Jemez Mountain unit, the location of Bandelier National Monument, Valles Caldera National Preserve (Anschueta & Merlan 2007; Martin 2003; Muldavin & Tonne 2003), and the town of Los Alamos. Here, the highest point in the area is Redondo Peak at 11,255 feet. This unit includes the Sierra Nacimiento which merges on its east flank with the Jemez. Unlike the Tusas and the Jemez Mountains, the Sierra Nacimiento was part of the Laramide orogeny as was the Sangre de Cristo Mountains to the east of the Rio Grande.

Based on Fenneman (1931), the Southern Rocky Mountain Physiographic Province includes the Tusas and the Jemez mountains, as well as the Sangre de Cristos to the east and the intervening Rio Grande Rift including the Taos Plateau. The lowlands to the west of the Tusas and Jemez mountains are in the Colorado Plateau Province, while those to the south of Santa Fe are in the Basin and Range Province.

Climate.—The climate of north central New Mexico is arid in the lowlands, increasing in moisture as one ascends in elevation. Precipitation is significantly affected by the North American monsoon. The monsoon results in a seasonal pattern of precipitation with a primary maximum during July, August, and September. Strong diurnal cloud cover and precipitation accompany this season. This corresponds with peak convective heating during the day leading to frequent afternoon thunderstorms (Sheppard et al. 1999). The mountains exert strong orographic effects on precipitation in direct relationship to elevation while temperature is inversely related. New Mexico receives between 30 and 40 percent of its annual precipitation during the summer months.

Winter tends to be drier, with a secondary maximum for precipitation occurring November through March (Sheppard et al. 1999). Winter precipitation is hydrologically important as winter snowpack recharges surface and ground water (Redmond 2003).

In the Rio Grande Rift, annual precipitation is about 10 inches at Española (elevation 5,640 feet) and 14 inches at Santa Fe (6,720); in the Tusas Mountains, 10 inches at Abiquiu Dam (6,300) and 14 inches at Tres Piedras (8,140); while in the Jemez Mountains, 17 inches at Jemez Springs (6,260), 18 inches at Los Alamos (7,300), and 23 inches at Wolf Canyon (8,220). Rain shadows may explain why Española and Abiquiu Dam, located in intermontane basins, receive the least annual precipitation. In the mountains, differential heating of east and west exposures and localized cold air drainag e also produce tremendous differences in climate over short distances (Eisenhood 1979). There is no long-term climate data for higher elevations in the mountains. The above precipitation data are based on a 30 year record (National Climatic Data Center 2009).

Drought during a portion of this study had an impact on collecting. Dry conditions were particularly severe in 2002 and 2003 and again in 2006 until the monsoon developed in late July and early August. Current drought conditions and climate change information for New Mexico can be obtained from the Governor's Drought Task Force (2008).

Geology and geomorphology.—The current landscape of the Southern Rocky Mountain Region is mainly a product of the Laramide Orogeny (late Cretaceous into the Tertiary (Eocene epoch), 70 to 55 million years ago (mya)) that produced the Sangre de Cristos and the Sierra Nacimiento. Subsequently, volcanism, erosion, infill, and subsidence of the mountains and basins occurred (Miller et al. 1992). Many older rock types of igneous origins have been uplifted and exposed as a result of the complex geologic history. Thus, the summits of the Sangre de Cristo and Tusas mountains consist of Precambrian rocks to 1.78 billion years in age.

The Tusas Mountains underwent extensive volcanic activity in the Tertiary (Bingler 1968). The northern portion received lava and ash flows from volcanic fields in the San Juan Mountains to the northwest. This portion of the range is now covered in ash-flow tuffs and volcaniclastic rocks of the Conejos Formation (New Mexico Bureau of Geology and Mineral Resources 2003).

The southern portion of the Tusas Mountains includes the Brazos uplift. This area is largely comprised of Precambrian granite, quartzite, schist, and gneiss (Bingler 1968). The surrounding valleys and slopes are covered in volcanic detritus eroded from the San Juan and northern Sangre de Cristo Mountains (Muehlberger & Muehlberger 1982).

During the Pleistocene, the Tusas Mountains were glaciated above 8,000 feet. Glacial outwash over Cretaceous strata has created large landslide deposits on its west slopes (Chronic 1987).

Separating the Tusas from the Jemez Mountains is the southern Chama Basin. It is filled with sandstones and shale of Jurassic and Triassic age (Smith et al. 1961). Present are fossils of the Upper Triassic that include conifers and cycads (Ash 1974). Of particular importance for the extant flora are outcrops of Todilto gypsum which harbor edaphic endemics such as *Abronia bigelovii* and *Astragalus micromerius* (New Mexico Rare Plant Technical Council 2008).

Volcanic activity intensified (10 mya) in the western Española Basin along the Rio Grande Rift. Repeated volcanic episodes gave rise to the Jemez Mountains, emerging directly out of the Rio Grande Basin. The earliest eruptions (9–11 mya) were basalt flows (e.g., caprock on Borrego Mesa) over arkosic sediments of the Santa Fe Group (Bailey & Smith 1978). Volcanic activity later culminated in a series of large pyroclastic eruptions at1.6 and again 1.2 mya that left a crater 16 miles in diameter and deposited many hundreds of feet of volcanic tuff (Goff et al. 1996). The center of the Jemez Mountains is defined by this crater that consists of broad valleys interrupted by resurgent domes. It is the site of the Valles Caldera National Preserve. The most recent eruption was 40,000–50,000 years ago from the El Cajete crater whose pumice outfall blanketed Bandelier National Monument. Numerous sources provide a more detailed description of the volcanic history and the resultant geologic structure of the Jemez (Goff et al. 1996; Kues et al. 2006; Smith et al. 1970).

The Rio Grande Rift was formed in the Cenozoic (70–0 mya). To the north it forms a broad, relatively flat surface of basaltic lava flows known as the Taos Plateau volcanic field. These flows issued from hundreds of vents during the Pliocene (Chronic 1987). The larger shield volcanoes are still prominent and include San Antonio and Ute mountains. Rocks from some vents are dated from 2.2 to 1.8 mya (Lipman 1978).

The Rio Grande Rift proper is a large trough formed in two phases. Ultimately, separate "subsided blocks or grabens with high topographic relief and bound by widely spaced, high angle normal faults" formed (Kelly 1990). Tremendous amounts of arkosic sediments, or quartzite derived sand, were deposited primarily from the Sangre de Cristo Mountains into the grabens. This led to the characteristic Santa Fe Group fill found within the Española Basin (Muehlberger & Muehlberger 1982).

The Rio Grande became a free-flowing river during the Pliocene, having overcome containment by a succession of closed basins within the Rift (Chronic 1987). On the Taos Plateau, it is now confined to the Rio Grande gorge.

METHODS

Field work on the Carson National Forest, the Santa Fe National Forest, and Valles Caldera National Preserve was conducted during the summers of 2001 through 2006 whereas the Bandelier National Monument was inventoried by Brian Jacobs from 1986 through 1988. These studies combined represent the most extensive and exhaustive floristic survey ever conducted in New Mexico.

Botanists have been roaming the country sides throughout the world for centuries, documenting the riches of floristic diversity. In keeping with the tradition of field botanists, collecting sites were selected and searched based on the researcher's judgment. Thus, the "meander search" strategy was employed (Goff et al. 1982; Ristau 1998; Hartman 1992; and Hartman & Nelson 2008). As sites were not selected at random, the result was the exploration of a much greater diversity of plant communities, soil types, geologic substrates, and topography leading to the documentation of a substantially greater diversity of taxa.

A total of 697 waypoints (each a geographic coordinate determined using a GPS unit) are represented in this paper (for the two thesis projects as a whole, the total was 1,542). Each waypoint represents a general location for collecting plant specimens, usually to within one-half mile (either as a radius from a point or a trail segment defined by two successive points). Details concerning collecting as followed in all RM studies are found in Hartman (1992) and Hartman and Nelson (2008).

Nomenclature in the Annotated Checklist follows Allred (2008) with some exceptions as treated in Hartman and Nelson (2001) or Flora of North America Editorial Committee, eds. (1993+).

This paper is based on 19,929 collections from the Tusas Mountains, Jemez Mountains, and vicinity (total number of collections obtained for the two thesis projects and the BNM inventory was 35,857 collections). A complete set of vouchers from CNF and SFNF are housed at RM. Bandelier specimens are housed at the monument herbarium with a partial set of duplicates at DUKE and miscellaneous vouchers at RM and UNM. All authors of this paper have made major contributions to the collection, identification, and verification of specimens as well as the writing of this paper.

The databases of the University of New Mexico Herbarium (UNM) and the Rocky Mountain Herbarium

(RM, USFS) were searched for species not encountered during our field studies. Their identifications were verified, and the institution and voucher is so indicated in the Annotated Checklist.

RESULTS AND DISCUSSION

The following sections will emphasize the results of research on the Tusas and Jemez mountains and vicinity with some discussion on various topics. Further aspects of the discussion will await the second paper on the Carson and Santa Fe National Forests to the east of the Rio Grande, thus data from the entire area.

Vegetation Types

New Mexico's vegetation has been partitioned and described in a number of studies at various spatial scales. The most relevant to this inventory are classifications by Brown (1994a, b), Daubenmire (1943), Dick-Peddie (1993), and Whittaker (1978). Vegetation types reported here are based on the application of the above-mentioned classifications as confirmed or modified by our observations. We report 14 vegetation types within five broad physiognomic and zonal categories. These may foster an understanding of the ecological amplitude, common associates, and environmental requirements of the taxa documented by these floristic inventories.

Forests and Woodlands

Spruce-fir forest.—These forests occur in subalpine habitats above 9,500 feet or on cooler and moister slopes at somewhat lower elevations. *Picea engelmannii* and *Abies arizonica* are codominants, although *Picea pungens* may occur as a seral species on moist sites (Moir 1993; Pase & Brown 1994a; U. S. Forest Service 1997). Scattered stands of *Populus tremuloides* may be present in disturbed areas. Conifers of lower elevations, such as *Pseudotsuga menziesii*, *Abies concolor*, and *Pinus flexilis*, may be present in low numbers. In the Tusas Mountains, spruce-fir forests were observed primarily around the Canjilon Lakes and Cruces Basin while in the Jemez Mountains they were common at higher elevations. The shrub and herb layer can be quite sparse due to the closed canopy.

Associated shrubs and subshrubs include Arctostaphylos uva-ursi, Juniperus communis, Paxistima myrsinites, Ribes wolfii, Salix scouleriana, Sambucus racemosa, and Vaccinium myrtillus. The herb layer is quite sparse yet may includes the forbs Actaea rubra, Castilleja sulphurea, Cymopterus lemmonnii, Ligusticum porteri, Pedicularis racemosa, Penstemon whippleanus, Solidago simplex, and Viola canadensis and such graminoids as Bromus ciliatus, B. richardsonii, Luzula parviflora, Poa leptocoma, Trisetum spicatum and T. montanum.

Mixed conifer forest.—This forest type covers large areas in the Tusas and Jemez mountains (8,000–10,000 feet). Small islands of mixed conifer forest are also found on the summits of the highest volcanic cinder cones on the Taos Plateau, including San Antonio Mountain, Ute Mountain, and Cerro de la Olla. *Pseudotsuga menziesii* and *Abies concolor* are the most widespread and important conifers. They occur with *Pinus strobiformis* in cooler sites while *Pinus flexilis* is found in dry, exposed areas, and *Abies arizonica* in the ecotones. *Picea pungens* is restricted to locations subject to cold-air inversions including lower slopes and drainages while *Pinus ponderosa* is found in xeric sites at lower elevations (DeVelice et al. 1986; Moir 1993). The mixed conifer forests are heterogeneous thus reflecting the landscape.

Common understory shrubs and subshrubs include Acer glabrum, Arctostaphylos uva-ursi, Berberis repens, Holodiscus dumosus, Jamesia americana, Juniperus communis, J. scopulorum, Paxistima myrsinites, Physocarpus monogynus, Rosa arkansana, R. woodsii, Symphoricarpos rotundifolius, and Vaccinium myrtillus. Forbs may be represented by Artemisia franserioides, Castilleja miniata, Cymopterus lemmonii, Fragaria vesca, Lathyrus leucanthus, Lithospermum multiflorum, Potentilla gracilis, Thalictrum fendleri, and Thermopsis rhombifolia, while frequent graminoides include Agrostis scabra, Blepharoneuron tricholepis, Carex siccata, C. geophila, C. occidentalis, Elymus trachycaulus, Muhlenbergia montana, and Achnatherum asperifolia.

Fire has created a natural mosaic within this vegetation type, with burns ranging from patchy, low intensity to stand replacing fires (U. S. Forest Service 1997; Moir 1993). Insect outbreaks and dwarf mistletoe also add to the patchwork.

Ponderosa pine forest.—Warmer and drier conditions from 6,700–8,500 feet support this forest type that often forms pure stands and occurs throughout the Tusas and Jemez mountains. At its upper limit, *Pinus ponderosa* and mixed conifer forests intergrade, while at its lower limit it merges into piñon-juniper woodland. However, ponderosa pine typically is the sole dominant conifer. Where trees are large and scattered the forests may be open and park-like, with a predominately grassy understory formed under pre-settlement fire conditions (Allen 2001; Moir 1993; Pase & Brown 1994b). Disturbance patterns in ponderosa pine forest include frequent, low intensity understory fires (DeVelice et al. 1986; Moir 1993; U.S. Forest Service 1997).

Associated deciduous shrubs in the understory include *Berberis repens, Ceanothus fendleri, Cercocarpus montanus, Fallugia paradoxa, Juniperus communis, Ribes cereum, R. inerme, R. leptanthus, Rosa acicularis, R. woodsii,* and *Symphoricarpos rotundifolius*. Relictual individuals of *Juniperus deppeana* are here documented for the Jemez Mountains. These are of Madrean origin with a center of distribution in Mexico (Peet 1988). Representative forbs include *Achillea millefolium, Amauriopsis dissecta, Antennaria parvifolia, Cymopterus lemmonii, Erigeron divergens, E. flagellaris, Heterotheca villosa, Hymenoxys richardsonii, Lithospermum multiflorum, Lupinus argenteus, Penstemon barbatus,* and *Vicia americana* while common graminoids include *Blepharoneuron tricholepis, Carex inops* ssp. *heliophila, Elymus elymoides* var. *brevifolius, Festuca arizonica, Koeleria macrantha, Muhlenbergia montana,* and *Poa fendleriana*.

Piñon-juniper woodland.—*Pinus edulis* and *Juniperus monosperma* are dominant in the foothills and form a discontinuous transitional belt (6,000 to 8,500 feet). Piñon-juniper woodlands represents the lowest elevation, forest type. Piñon forms closed woodlands at the upper elevational range, whereas juniper occurs in savanna-like communities at the lower elevational range and interface with grasslands. *Juniperus scopulorum* commonly occurs with piñon in mesic settings and has recently encroached into *Pinus ponderosa* understories in absence of fire disturbance (U.S. Forest Service 1997). Understory conditions are dynamic and vary with canopy cover, soil conditions, and land use and fire history (West 1999).

Shrub cover is variable and includes *Quercus gambelii* and *Q. undulata*, but also *Artemisia tridentata, Cercocarpus montanus, Gutierrezia sarothrae, Fallugia paradoxa, Ribes cereum,* and *Rhus trilobata*. Forbs include *Castilleja integra, Chaetopappa ericoides, Chamaesyce fendleri, Cryptantha cinerea, Eriogonum jamesii, Gaillardia pinnatifida, Hymenoxys richardsonii, Lappula occidentalis, Oenothera suffrutescens, Sphaeralcea coccinea,* and *Tetraneuris argentea* with several succulents including *Cylindropuntia imbricata, Opuntia phaeacantha, O. polyacantha,* and *Yucca* spp. Common graminoids are *Achnatherum hymenoides, Aristida purpurea, Bouteloua curtipendula, B. gracilis, Carex geophila, Elymus elymoides, Hesperostipa comata, Hilaria jamesii, Koeleria cristata, Muhlenbergia torreyi, Piptatherum micranthum,* and *Poa fendleriana*.

Historic impacts in woodlands are extensive and include fuel harvest and grazing (Moir 1993). Degraded conditions due to historic grazing are often characterized by high densities of *Juniperus monosperma* and intercanopy spaces dominated by *Bouteloua gracilis* and *Gutierrezia sarothrae* with exposed soils and active erosion. Bark beetle outbreaks of *Ips confusus* associated with drought stress can result in high levels of piñon mortality with the most recent events peaking in 2002 (Breshears et al. 2005).

Shrublands

Montane Shrubland.—These shrublands are found throughout the Tusas and Jemez mountains. They are distributed in a patchy manner throughout ponderosa pine forest or piñon-juniper woodland. Areas of montane shrubland are often too limited in extent for mapping because they are produced by site-specific factors: past disturbance, local substrate, and patterns of moisture. Comparably drier and more rocky sites are typical of montane shrubland, although some associates such as *Prunus virginiana* and *Ptelea trifoliata* are found in areas of increased moisture such as small catchments (Dick-Peddie 1993).

Included in this classification of montane shrubland are thick stands of *Quercus gambelii* and *Robinia neomexicana*. These species occur on soils that are poorly developed and xeric (Brown 1994a) and have also been regarded as a seral association produced by past disturbance (Dick-Peddie 1993). Also included here is the "climax" shrubland of Dick-Peddie (1993) or *Cercocarpus montanus* in association with *Amelanchier alnifolia, Philadelphus microphyllus, Quercus undulata*, and *Rhus trilobata*. Other shrubs include *Ceanothus fendleri, Holodiscus dumosus, Jamesia americana, Juniperus communis, Physocarpus monogynus, Ribes cernum, R. inerme, Rubus parviflorus, Sambucus racemosa*, and *Symphoricarpos rotundifolius*.

Desert Shrubland.—There are three subtypes that qualify as desert shrubland. One is found within a large area of the Taos Plateau, especially west of the Rio Grande. This subtype is characterized by the absence of *Artemisia tridentata* var. *tridentata* and the presence of a number of other shrubs and subshrubs. Included are *Artemisia nova, Atriplex canescens, Chrysothamnus greenei, Ericameria nauseosa, Gutierrezia sarothrae*, and *Tetradymia canescens*.

The second subtype, the desert scrub, is dominated by *Artemisia tridentata* var. *tridentata*. It most often occurs in openings or glades within piñon-juniper woodland. *Atriplex canescens, Cylindropuntia imbricata*, and *Ericameria nauseosa* are common woody associates.

The third subtype is sand scrub found in dune areas on old floodplains of the Rio Chama and Rio Grande. Some shrub and subshrubs include *Atriplex canescens, Gutierrezia sarothrae, Krascheninnikovia lanata*, and *Rhus trilobata*.

The herbaceous cover is often sparse in desert shrublands but may include the forbs Castilleja integra, Chaetopappa ericoides, Croton texensis, Eriogonum annuum, E. microthecum, Ipomopsis multiflora, and the grasses Achnatherum hymenoides, Aristida purpurea, Bouteloua gracilis, Elymus smithii, Muhlenbergia torreyi, and Sporobolus airoides.

Grasslands

Montane meadow and grassland.—This vegetation type occurs from about 8,500 feet to the highest summits throughout the Tusas and Jemez mountains. Upper-elevation sites may be extensive and uninterrupted, whereas lower sites are often surround by coniferous forests. *Blepharoneuron tricholepis, Danthonia parryi, Festuca idahoensis, F. thurberi, Koeleria macrantha, Muhlenbergia montana*, and *Poa fendleriana* dominate at higher elevations, while forbs and exotic species may outnumber grasses in lower elevation meadows. These grasslands are frequently associated with areas where poor drainage or other edaphic conditions inhibit tree establishment (Brown 1994b). While species composition varies with elevation and moisture levels, montane meadows are characterized by a diverse array of grasses and forbs. Some frequent representatives of the latter group include *Achillea millefolium, Campanula rotundifolia, Carex microptera, Eremogone fendleri, Erigeron flagellaris, Erysimum capitatum, Frasera speciosa, Heterotheca villosa, Hymenoxys richardsonii, H. hoopesii, Ipomopsis aggregata, Iris missouriensis, Lupinus argenteus, Orthocarpus luteus, Potentilla hippiana, P. gracilis*, and *Thermopsis rhombifolia*.

Generally, this vegetation type has experienced a high level of disturbance by humans. Loss of natural fire cycles often leads to encroachment by woody plants. Overgrazing and changes in climate also may have an effect (Merola-Zwartjes 2004; Raish 2004; Dick-Peddie 1993).

Plains-desert grassland.—This vegetation type is ecotonal to piñon-juniper woodlands or juniper savannas. It may be interspersed with, or sometimes indistinguishable from, Great Basin desert scrub (Dick-Peddie 1993). Desert grassland occurs primarily along the Rio Grande Rift, on the edge of, or within, surrounding piñon-juniper woodlands, and to the west of the Tusas and Jemez mountains where it is transitional to desert. It has a significant shrub and forb cover. Characteristic grasses are *Achnatherum hymenoides, Aristida purpurea, Bouteloua gracilis, B. curtipendula, Elymus smithii, Hesperostipa comata*, and *Hilaria jamesii*, while frequently encountered forbs include *Antennaria microphylla, A. rosea, Castilleja integra, Cryptantha* spp., *Glandularia bipinnatifida, Grindelia squarrosa, Oenothera coronopifolia, O. suffrutescens, Opuntia polyacantha, O. phaeacantha, Ratibida tagetes, Sphaeralcea coccinea, Teucrium laciniatum*, and *Zinnia grandiflora*.

Wetlands

Montane Riparian.—Margins of perennial and intermittent streams support variable species assemblages. Montane riparian vegetation is found in moist areas within spruce-fir and mixed conifer forests. The above are especially well developed in the Jemez Mountains but may also be encountered in the northern Tusas Mountains. As with montane meadows, the species composition follows an elevation gradient (Dick-Peddie 1993). Obligate and facultative riparian species of trees and shrubs can be arranged along a descending gradient: *Picea pungens*, *Salix bebbiana*, *Alnus incana*, *Acer glabrum*, *Cornus sericea*, *Populus angustifolia*, and *Acer negundo*. Additional facultative riparian trees and shrubs include *Populus tremuloides*, *Prunus virginiana*, *Quercus gambelii*, and *Robinia neomexicana*. Among the rich diversity of forbs are *Aconitum columbianum*, *Caltha leptosepala*, *Cardamine cordifolia*, *Equisetum arvense*, *Geum macrophyllum*, *Heracleum maximum*, *Hypericum scouleri*, *Mertensia fransiscana*, *Mimulus guttatus*, *Oxypolis fendleri*, *Pedicularis groenlandica*, *Saxifraga odontoloma*, *Veronica americana*, and species of *Epilobium*, *Potamogeton*, *Ranunculus* and *Salix*. Graminoids include *Alopecurus aequalis*, *Deschampsia cespitosa*, *Elymus canadensis*, *Glyceria grandis*, *G. striata*, *Juncus arcticus*, *Torreyochloa pallida*, and species of *Agrostis*, *Carex*, and *Eleocharis*.

Floodplain-arroyo riparian.—This type of vegetation occurs at lower elevations on floodplains of the major rivers, the Chama, Jemez, and Rio Grande, or in arroyos which drain bajadas and mesas. Many species that thrive here are well adapted to disturbance and dry conditions with periodic flooding. The most common dominate is *Populus deltoides*, with the understory shrubs *Baccharis salicina*, *Ericameria nauseosa*, *Fallugia paradoxa*, *Forestiera pubescens*, *Rhus trilobata*, and *Salix exigua*. The exotics, *Elaeagnus angustifolia* and *Tamarix chinensis* have proliferated and may persist in a subclimax state (Minckley & Brown 1994; Dick-Peddie 1993). Arroyo riparian is typically adjacent to desert shrubland and may grade into montane riparian.

Marsh-lacustrine.—The marsh-lacustrine riparian habitat is found around ponds, springs, and stock tanks in otherwise arid habitats such as piñon-juniper woodland or desert grassland where the water table remains sufficiently high, or in various montane vegetation types. Along the shoreline *Limosella aquatica*, *Potentilla anserina*, *P. norvegica*, *Ranunculus cymbalaria*, *Rorippa* spp., and *Rumex crispus* may be encountered. Emergents include *Scirpus microcarpus*, *Sparganium emersum*, *Typha latifolia* and species of *Carex*, *Eleocharis*, *Juncus*, and *Schoenoplectus*. Floating and submersed taxa include *Callitriche palustris*, *Potamogeton* spp., *Lemna minor*, *Elodea canadensis*, *Myriophyllum sibiricum*, *Ranunculus aquatilis*, and *Zannichellia palustris*.

Disturbed

Aspen seral forest.—*Populus tremuloides*, an important seral species and post-fire increaser, is widely distributed in the Rocky Mountains (Peet 1988). Pure stands of this shade-intolerant species arise through root sprouting following disturbances (Pase & Brown 1994b). Scattered individuals are also found in late-succession or near climax stages in mixed conifer forest and lower subalpine spruce-fir forests (Moir 1993). However, like many successional communities, aspen forms a distinct assemblage that may persist for long periods of time. Aspen are found in various coniferous forest types throughout the Tusas and Jemas mountains.

Forbs include *Campanula rotundifolia*, *Castilleja miniata*, *Chamerion angustifolia*, *Geranium richardsonii*, *Pseudostellaria jamesiana*, and *Thalictrum fendleri* while frequently encountered grasses included *Poa fendleriana*, *P. pratensis*, *Bromus carinatus*, *B. richardsonii*, and *Festuca arizonica*.

Burn Areas.—Natural and anthropogenic fires have been frequent in most of the vegetation types, as mentioned above. In this regard the Jemez Mountains has been extensively researched. Over 5,200 fires have been documented between 1906 and 1996, 75 percent of which were initiated by lightning (Allen 2001). Allen also described near continuous fire activity during the last 9,000 years based in large part on fire scars on trees and the charcoal record at Alamo Bog (VCNP). Recent extensive fires in the Jemez Mountains include the Dome (16,000 acres, 1996), the Cerro Grande (45,000 acres, 2000), and the Borrego (12,700 acres, 2002).

Roadside-agricultural.—Here, native vegetation may be largely replaced by exotic or agricultural species. Noxious weeds collected along roads include *Aegilops cylindrica*, *Cirsium vulgare*, *Convolvulus arvensis*, *Lepidium latifolium*, *Linaria dalmatica*, and *Ulmus pumila*. Weedy or agricultural plants include *Avena sativa*, *Helianthus annuus*, *Salsola tragus*, *Sisymbrium altissimum*, *Tragopogon dubius*, and species of *Ambrosia*, *Bromus*, *Chamaesyce, Chenopodium, Elymus, Lappula, Lepidium, Medicago, Melilotus, Plantago, Polygonum,* and *Trifolium.* Roadsides often act as corridors for exotics and thus warrant monitoring.

NOXIOUS WEEDS

Invasive exotic plants are a principal cause for the loss of biodiversity (Randall 1996; Wilcove et al. 2000). In natural areas, invasive plants are defined as those which produce significant alterations in plant composition, structure, and ecosystem functions (Cronk & Fuller 1995). Invasive plant species that are particularly damaging or prolific are regulated as noxious weeds (Natural Resources Conservation Service 2008). A specific goal of our floristic inventories was to document noxious weeds for the purpose of assisting in monitoring and control efforts. Of the 32 taxa listed in New Mexico, 14 were encountered at 166 sites. They are *Acroptilon repens, Aegilops cylindrica, Carduus nutans, Cirsium arvense, C. vulgare, Conium maculatum, Convolvulus arvensis, Elaeagnus angustifolia, Hyoscyamus niger, Lepidium latifolium, Linaria dalmatica, Linaria vulgaris, Tamarix chinensis,* and *Ulmus pumila.* Noxious weeds and other exotics are indicated by a • or an *, respectively, in the Annotated Checklist.

TAXA OF CONSERVATION CONCERN

A primary goal of the inventories was to document the occurrence of rare and endemic taxa. A total of 22 species of conservation concern were documented from 49 sites in the Tusas and Jemez mountains and vicinity; four additional records were verified from accessions at UNM. The status is based on plants so designated by Natural Heritage New Mexico (2008) and New Mexico Rare Plant Technical Committee (2008). These taxa are listed alphabetically and each is followed by family name, counties of occurrence (apparent new county records in **bold**), and voucher(s). They also are indicated by a ♦ in the Annotated Checklist.

Abronia bigelovii (Nyctaginaceae) Rio Arriba, Sandoval, Santa Fe: *Larson 4113; Hartman 80977.*

Astragalus cyaneus (Fabaceae) Rio Arriba, Santa Fe, Taos: *Larson 10438, 10480; Hartman 81069; Nelson 67934.*

Astragalus iodopetalus (Fabaceae) Rio Arriba, Sandoval, Taos: *Hartman 74741.*

Astragalus micromerius (Fabaceae) McKinley, Rio Arriba, San Juan: *Larson 4112.*

Astragalus ripleyi (Fabaceae) Rio Arriba, Taos: *Larson 2023; Hartman 81215.*

Cornus canadensis (Cornaceae) Sandoval, Taos: *Hartman 75528, 75600, 75667; Jacobs 5183.*

Corydalis caseana ssp. **brandegeei** (Fumariaceae) Rio Arriba: *Larson 4533.*

Cymopterus sessiliflorus (Apiaceae) Cibola, McKinley, Rio Arriba, San Juan, Sandoval, Taos, Valencia: *Larson 5024, 10348.*

Cypripedium parviflorum var. **pubescens** (Orchidaceae) Catron, Grant, **Los Alamos,** San Miguel, Santa Fe: *Jacobs 3621, 5112.*

Epipactis gigantea (Orchidaceae) Catron, Eddy, Grant, Guadalupe, Harding, Los Alamos, Otero, **Rio Arriba,** Sandoval: *Hartman 74454; Jacobs 3885; Larson 5027.*

Eriogonum lachnogynum var. **colobum** (Polygonaceae) McKinley, **Taos**: *Hartman 81819, 81828.*

Grindelia decumbens var. **subincisa** (Asteraceae) Hidalgo, Grant, Rio Arriba, Sandoval: *Larson 8648, 9233; Nelson 61956.*

Hackelia hirsuta (Boraginaceae) Colfax, **Los Alamos**, Mora, Rio Arriba, Sandoval, San Miguel, Santa Fe, Taos, Union: *Jacobs & Perkins 3636.*

Lilium philadelphicum (Liliaceae) Sandoval, San Miguel, Santa Fe: *Jacobs 3695.*

Lorandersonia microcephala (Asteraceae) Rio Arriba, Taos: *Larson 3626; Hartman 83194, 83298.*

Mentzelia conspicua (Loasaceae) Rio Arriba: *Reif 1973.*

Mentzelia springeri (Loasaceae) Los Alamos, Sandoval, Santa Fe: *Fox s.n.; Hartman 75084; Jacobs 3202, 3296, 3904, 5124.*

Muhlenbergia arsenei (Poaceae) Sandoval, Santa Fe: *Hartman 75187; Jacobs 3094, 3209, 4536.*

Podistera eastwoodiae (Apiaceae) Mora, **Rio Arriba,** Santa Fe, San Miguel: *Hartman 75028.*

Ranunculus abortivus (Ranunculaceae) **Rio Arriba, Sandoval,** Taos: *Jacobs 3499; Reif 447, 6543, 6678.*

Salix arizonica (Salicaceae) Mora, Rio Arriba, Taos: *Hartman 75017.*

Spiranthes romanzoffiana (Orchidaceae) Rio Arriba, Sandoval, Santa Fe, Taos: *Hartman 78326.*

The following, also of conservation concern, were encountered in searches of the University of New Mexico database; identifications have been verified: **Astragalus puniceus** var. **gertrudis** (Fabaceae; UNM), **Lomatium grayi** var. **grayi** (Apiaceae; UNM), **Eustoma exaltatum** (Gentianaceae; UNM), and **Parnassia fimbriata** (Parnassiaceae; UNM).

State Records for New Mexico

Species from the Tusas and Jemez mountains and vicinity that appear to be new to the flora of New Mexico, or that have had reports verified, are listed below (based on Allred 2008). A total of 28 apparent state records based on 78 collections are included along with three additional records verified from accessions at RM and UNM. The 18 taxa preceded by an ‘ were documented in Hartman et al. (2006). Of these, *Carex deweyana* var. *deweyana* previously had been reported by McGrath (2005). These taxa are listed alphabetically and each is followed by the family name, the number of collections, and the counties of occurrence. They are indicated by an ! in the Annotated Checklist.

‘Achnatherum nelsonii var. **nelsonii** (Poaceae) 7, Rio Arriba, Sandoval
Astragalus cerussatus (Fabaceae) 3, Rio Arriba, Taos
‘Betula glandulosa (Betulaceae) 2, Sandoval
‘Cardamine cordifolia var. **incana** (Brassicaceae) 1, Rio Arriba
‘Carex deweyana var. **deweyana** (Cyperaceae) 2, Los Alamos, Rio Arriba
‘Carex rosea (Cyperaceae) 1, Sandoval
Chenopodium capitatum (Chenopodiaceae) 1, Sandoval
‘Cynosurus echinatus (Poaceeae) 1, Sandoval
Descurainia pinnata var. **paysonii** (Brassicaceae) 1, Rio Arriba
Epilobium campestre (Onagraceae) 1, Rio Arriba
Epilobium ciliatum var. **glandulosum** (Onagraceae) 4, Rio Arriba, Sandoval
‘Equisetum ×nelsonii (Equisetaceae) 1, Sandoval
‘Erigeron nivalis (Asteraceae) 3, Sandoval
‘Geum triflorum var. **triflorum** (Rosaceae) 1, Sandoval
Hieraceum ×floribundum (Asteraceae) 3, Rio Arriba, Sandoval
‘Juglans nigra (Juglandaceae) 2, Sandoval
‘Lactuca biennis (Asteraceae) 2, Sandoval
Lepidium densiflorum Schrad. var. **macrocarpum** G. A. Mulligan (Brassicaceae) 1, Rio Arriba
‘Lepidium ramosissimum var. **bourgeauanum** (Brassicaceae) 25, Rio Arriba, Sandoval
Mimulus suksdorfii (Plantaginaceae) 1, Rio Arriba
‘Neoparrya lithophila (Apiaceae) 2, Taos
‘Penstemon glaber var. **alpinus** (Plantaginaceae) 1, Los Alamos
‘Piptatherum pungens (Poaceae) 1, Sandoval
‘Prunus persica (Rosaceae) 2, Sandoval
‘Ranunculus alismifolius var. **montanus** (Ranunculaceae) 5, Rio Arriba
‘Ranunculus repens (Ranunculaceae) 1, Sandoval
Silene drummondii var. **striata** (Caryophyllaceae) 2, Rio Arriba
Sium suave (Apiaceae) 1, Rio Arriba

The following taxa that also appear to be state records were encountered in searches of the University of New Mexico and the Rocky Mountain databases; identifications have been verified: **Carex tahoensis** (Cyperaceae; UNM, 2 collections), **Lomatium grayi** var. **grayi** (Apiaceae; UNM), and **L. triternatum** var. **platycarpum** (Apiaceae; RM).

SUMMARY OF TAXA

The first number represents results based on our fieldwork. Parenthetical numbers following most of the former include those verified from other herbaria. The two adjacent numbers below "Exotic taxa" represent the percent of exotics when compared to total Unique taxa.

List by taxonomic category		**List by special category**	
Families	107	Exotic taxa	154 (158)
Genera	519 (533)	Percent exotic taxa	(11.1) (9.1)
Species	1,279 (1,334)	NM Noxious weeds	14
Hybrids	10	Species conservation concern	22 (26)
Infraspecies	93 (98)	NM Endemic taxa	17 (18)
		State records	28 (31)
Unique taxa	1,384 (1,445)		

List of unique taxa by major plant group	
Fern Allies	7 (8)
Ferns	20 (23)
Gymnosperms	16
Angiosperms	1,341 (1,398)
Total	1,384 (1,445)

CONCLUSIONS

This paper represents the first of two contributions that cover the floristic diversity in north central New Mexico. The area here covered encompasses the Tusas Mountains and the Jemez Mountains (including Sierra Nacimiento) of the Carson National Forest and Santa Fe National Forest. Also included is Bandelier National Monument, Valles Caldera National Preserve, and other federal, state, and private lands west of the Rio Grande. We report on results of 19,929 numbered collections of vascular plants (total for the two-part series covering more than 3.7 million acres is 35,857 new collections). A total of 1,384 unique taxa, including 93 infraspecies as well as 10 hybrids, are documented from 107 families. With the addition of 60 taxa (totals within parentheses) verified from four herbaria, the total for unique taxa rise to 1,445. Of these, 154 (158) are exotic taxa of which 14 are designated as noxious in New Mexico, 22 (26) are species of conservation concern, 28 (31) represent first reports or their confirmation for New Mexico, and 17 (18) are endemic to the state.

THE ANNOTATED CHECKLIST

The checklist is divided into major plant groups (ferns and fern allies, gymnosperms, and angiosperms) each with alphabetical listings by family and species. Nomenclature follows Allred (2008) with some exceptions as treated in Hartman and Nelson (2001) or Flora of North America Editorial Committee, eds. (1993+). Where these deviations occur, Allred's scientific name appears in square brackets below the accepted name.

Following is a guide to format and abbreviations associated with individual taxa in the checklist. Except for records based on specimens at RM, or UNM, the citation of vouchers are omitted. This is justified as collection data are available online (Hartman et al. 2009).

Taxon Authority [#, # +INITIALS, #, #] COUNTY; elevational range in feet; GEOLOGIC AREA; habitat type.

[*Taxon* Authority, name accepted by Allred]

The number of collections for each project is based on the position of the pound sign (#) within square brackets: **[#,-,-,-]** Jemez Mountains and vicinity, **[-,#,-,-]** Valles Caldera National Preserve, **[-,-,#,-]** Bandelier National Monument, and **[-,-,-,#]** Tusas Mountains and vicinity.

Other attributes include herbaria of origin with specific vouchers cited, e.g., **[UNM-**Lowrey *1645*] (**RM,** Rocky Mountain Herbarium; **UNM,** University of New Mexico Herbarium, **USFS,** National Herbarium of the U. S. Forest Service at RM) and associated initials, e.g., [-,C,-,-] or [-,#+N,-,-] representing contributor of VCNP data (C, Jonathan Coop; H, Natural Heritage New Mexico; N, Neal Osborne). Vouchers by Jonathan Coop are at the University of Wisconsin (verified by Andrew Hipp) whereas those by the Natural Heritage New Mexico or Neal Osborn (1966) are at the UNM (verified by Hartman).

County abbreviations:

L	**L**os Alamos
R	**R**io Arriba
D	San**D**oval
S	**S**anta Fe
T	**T**aos

Geologic area:

J	**J**emez Mountains, s. of Chama River
G	Rio **G**rande Rift, s. of Black Mesa
P	Taos **P**lateau, n. of Black Mesa
U	T**U**sas Mountains, n. of Chama River

Habitat type:

af	Aspen seral forest
br	Burns
ds	Desert shrubland
fr	Floodplain-arroyo riparian
mc	Mixed conifer forest
ml	Marsh-lacustrine
mm	Montane meadow and grassland
mr	Montane riparian
ms	Montane shrubland
pg	Plains-desert grassland
pj	Piñon-juniper woodland
pp	Ponderosa pine forest
ra	Roadside-agricultural
sf	Spruce-fir forest

Symbols by category preceding *Taxon*:

* Exotic species to New Mexico
• Noxious weed in New Mexico
+ Endemic to New Mexico
♦ Species of conservation concern
! State record for New Mexico
× Hybrid

FERNS AND FERN ALLIES

Aspleniaceae

Asplenium septentrionale (L.) Hoffm. **[1,3,1,1]** D, R; 8300–9840′; **J, U;** mm, mc, mr.

Asplenium trichomanes L. **[1,-,-,1]** D, R; 8200–8460′; **J, U;** mm, mr.

Dennstaedtiaceae

Pteridium aquilinum (L.) Kuhn var. *pubescens* Underw. **[12,13,1,-]** D, L, R; 7350–9920′; **J, U;** af, br, mc, mm, mr, ms, ra.

Dryopteridaceae

Athyrium filix-femina (L.) Roth ex Mert. var. *californicum* Butters **[7,5,1,-]** D, L, R; 6700–10000′; **J, U;** mc, mm, mr, ms, sf.

Cystopteris fragilis (L.) Bernh. **[9,7,3,3]** D, L, R; 6600–10600′; **J, U;** af, mc, mm, mr, ms, pp, sf.

Cystopteris reevesiana Lellinger **[12,20,1,-]** D, L, R; 7450–10330′; **J, U;** af, mc, mm, mr, ms, pp, sf.

Dryopteris filix-mas (L.) Schott **[10,9,4,3]** D, L, R; 6150–9325′; **J, U;** af, mc, mm, mr, ms, pj, pp.

Woodsia neomexicana Windham **[1,1,1,1]** D, R; 6150–8940′; **J, U;** mm, mr, pj, pp.

Woodsia oregana D.C. Eaton var. *cathcartiana* (B.L. Rob.) Morton **[-,3,1,2]** D, R, T; 6660–10300′; **J, P, U;** ds, mm, mr, pj, pp.

Woodsia plummerae Lemmon **[1,-,-,1]** D, T; 7150–8460′; **J, P;** mm, pj.

Equisetaceae

Equisetum arvense L. **[31,8,6,10]** D, L, R; 5500–10020′; **J, G, P, U;** fr, ml, mm, mr, ra.

× *Equisetum* ×*ferrissii* Clute **[3,1,-,-]** D, R; 5825–8600′; **J;** fr, mr, ra.

Equisetum hyemale L. var. *affine* (Engelm.) A.A. Eaton **[8,-,2,1]** D, L, R; 6000–8450′; **J, U;** fr, mm, mr.

Equisetum laevigatum A. Braun **[19,4,2,7]** D, L, R; 5550–8950′; **J, G, U;** fr, ml, mm, mr, ra.

!× *Equisetum* ×*nelsonii* (A.A. Eaton) J.H. Schaffn. **[-,-,1,-]** D; 5300′ **J;** mr.

Ophioglossaceae

Botrychium lanceolatum (S.G. Gmel.) Ångstr. var. *lanceolatum* [**UNM**-McGrath 250] R; **U.**

Botrychium virginianum (L.) Sw. **[-,-,1,-]** L; 7150′; **J;** mr.

Polypodiaceae

Polypodium hesperium Maxon [**UNM**-Windham 357B] R; **U.**

Polypodium saximontanum Windham [**UNM**-Stanley 11195] R; **U.**

Pteridaceae

Argyrochosma fendleri (Kunze) Windham **[2,-,2,1]** D, S, T; 5400–7020′; **G, P;** ds, fr, mr.

Cheilanthes eatonii Baker **[-,1,1,2]** D, R, T; 6600–9050′; **J, P, U;** ms, pp, pj.

Cheilanthes feei T. Moore **[2,-,1,3]** D, R; 5500–7200′; **J, U;** ms, pj.

Cheilanthes fendleri Hook. **[-,1,2,2]** D, R, T; 5500–8670′; **J, P, U;** mc, ms, pj, ra.

Cheilanthes wootonii Maxon **[1,-,-,-]** L; 7500–8900′; **J;** mc.

Cryptogramma acrostichoides R. Br. **[-,2,-,1]** D, R; 8300–11150′; **J, U;** mm, pp, sf.

Notholeana standleyi Maxon **[-,-,1,-]** D; 6000′; **J;** pj.

Pellaea truncata Goodding **[-,-,2,1]** D; 5400–5500′; **J, P;** pj.

Pellaea wrightiana Hook. **[-,-,1,-]** D; 6100′; **J;** pj.

Selaginaceae

Selaginella densa Rydb. **[-,-,-,8]** R, T; 7150–10200′; **P, U;** mm, ms, pp.

Selaginella mutica D.C. Eaton ex Underw. var. *mutica* **[3,-,1,-]** D, S; 5860–6200′; **J, G;** ds, fr, ms, mr.

Selaginella underwoodii Hieronymus [**UNM**-*Clark 9628*] D; **J.**

GYMNOSPERMS

Cupressaceae

Juniperus communis L. var. *depressa* Pursh **[37,33,2,23]** D, L, R, T; 7500-11150′; **J, P, U;** af, mc, mm, mr, ms, pp, sf.

Juniperus deppeana Steud. var. *deppeana* **[4,-,2,-]** D; 6600–7210′; **J;** pp, pj.

Juniperus monosperma (Engelm.) Sarg. **[32,-,4,32]** D, R, T; 5470–8460′; **J, G, P, U;** ds, fr, mr, ms, pg, pj, pp, ra.

Juniperus scopulorum Sarg. **[24,4,3,48]** D, R, T; 6000–9400′; **J, P, U;** mc, mr, ms, pg, pj, pp, ra.

Ephedraceae

Ephedra cutleri Peebles **[-,-,5,-]** D, 5600–5900 **J;** pj.

Ephedra torreyana Torr. ex S. Watson var. *torreyana* **[-,-,1,3]** D, R; 6100–6340′; **J, U;** ds, fr, pj.

Ephedra trifurca Torr. ex S. Watson **[2,-,-,-]** L, S; 5470–6100′; **G;** ds, pg.

Pinaceae

Abies arizonica Merriam **[9,17,1,5]** D, L, R, T; 8340–11150′; **J, U;** af, mc, mr, sf.

Abies concolor (Gord. & Glend.) Hildebr. **[49,42,2,23]** D, L, R; 6800–10650′; **J, P, U;** af, br, mc, mm, mr, pp, sf.

Picea engelmannii Parry ex Engelm. var. *engelmannii* **[9,19,1,12]** D, L, R; 8375–11150′; **J, P, U;** af, mc, mm, mr, sf.

Picea pungens Engelm. **[25,17,1,11]** D, R; 7450–10200′; **J, P, U;** af, br, mc, mm, mr, pp, ra, sf.

Pinus edulis Engelm. **[41,3,4,56]** D, L, R, T; 5860–9850′; **J, G, P, U;** ds, fr, mc, ms, pg, pj, pp, ra.

Pinus flexilis E. James **[10,6,2,2]** D, L, R; 7450–10225′; **J, U;** af, br, mc, pp, sf.

Pinus ponderosa Douglas ex P. Lawson & C. Lawson var. *scopulorum* Engelm. **[66,27,1,36]** D, L, R, T; 6150–10650′; **J, G, P, U;** br, mc, mm, mr, ms, pj, pp, ra.

Pinus strobiformis Engelm. **[18,21,1,-]** D, L, R; 8000–10650′; **J;** mc, mr, ms, pp, sf.

Pseudotsuga menziesii (Mirb.) Franco var. *glauca* (Beissn.) Franco **[47,29,5,29]** D, L, R, T; 6000–11150′; **J, P, U;** af, br, mc, mm, mr, pp, sf.

ANGIOSPERMS

Aceraceae [as Sapindaceae]

Acer glabrum Torr. var. *glabrum* **[37,21,3,5]** D, L, R; 6400–10900′; **J, U;** af, br, mc, mm, mr, ms, pp, sf.
[*Acer glabrum* Torr. var. *neomexicanum* (Greene) Kearney & Peebles]

Acer negundo L. var. *interius* (Britton) Sarg. **[4,-,4,1]** D, L, R; 5600–8280′; **J, G, U;** fr, mr, ra.

Adoxaceae
Adoxa moschatellina L. **[4,-,-,-]** D; 8350–8475′; **J;** mm, mr.
Sambucus racemosa L. var. *melanocarpa* (A. Gray) McMinn **[9,-,-,-]** D, R; 7200–10430′; **J;** af, mc, mm, mr, pp, ra, sf.
Sambucus racemosa L. var. *microbotrys* (Rydb.) Kearney & Peebles **[20,11,2,2]** D, L, R; 7780–11254′; **J, U;** af, br, mc, mm, mr, sf.

Agavaceae [includes Nolinaceae]
Nolina microcarpa S. Watson **[-,-,1,-]** D; 6100′; **J;** pj.
Yucca baccata Torr. var. *baccata* **[2,1,1,7]** D, R, S, T; 5860–8630′; **J, G, P, U;** ds, mm, ms, pj, pp.
+ *Yucca intermedia* McKelvey **[9,-,1,11]** D, R, T; 5500–8750′; **J, G, P, U;** ds, fr, mc, ms, pg, pj, pp, ra.
[*Y. baileyi* Wooton & Standl. var. *intermedia* (McKelvey) Reveal; see Sivinski 2008]

Alismataceae
Alisma subcordatum Raf. [**UNM**-Atwood 21196] R; **U.**
Sagittaria cuneata E. Sheld. **[1,1,-,1]** D, R; 6500–8550′; **J, U;** ml, mr.

Alliaceae [traditionally in Liliaceae]
Allium bisceptrum S. Watson **[1,-,-,-]** R; 9300–10135′; **J;** mc.
Allium cernuum Roth **[15,27,1,21]** D, L, R, T; 7300–10300′; **J, P, U;** af, br, ds, mc, mm, mr, ms, pj, pp.
Allium geyeri S. Watson var. *geyeri* **[3,17,1,5]** D, R; 7550–9625′; **J, U;** af, mc, mm, mr, ms, pp.
Allium geyeri S. Watson var. *tenerum* M.E. Jones **[-,-,1,2]** D, R; 8950–10600′; **J, U;** mm, mr.
Allium macropetalum Rydb. **[2,-,1,-]** D, R; 6250–7360′; **J;** ds, pj.
Allium textile A. Nelson & J. F. Macbr. **[-,-,-,5]** R, T; 6200–7150′; **P, U;** fr, pj.

Amaranthaceae
Amaranthus albus L. **[2,-,2,3]** D, L, R, T; 5450–8740′; **J, G, P, U;** fr, ml, mm, pj, ra.
Amaranthus arenicola I.M. Johnst. **[-,-,2,-]** D; 5800–6000′; **J;** pp.
* *Amaranthus blitoides* S. Watson **[-,-,1,1]** L, T; 6500–8500′; **J, P;** ml, pj.
* *Amaranthus hybridus* L. **[-,-,3,-]** D; 6000–6450′; **J;** pj.
* *Amaranthus hypochondriacus* L. **[-,-,1,-]** D; 5300′; **J;** fr.
Amaranthus powellii S. Watson **[-,1,-,7]** D, R, T; 6975–8400′; **J, P, U;** ds, mr, pj, pp, ra.
* *Amaranthus retroflexus* L. **[4,5,4,-]** D, L, R; 5400–9220′; **J, G, P;** mm, pp, pj, ra.
Amaranthus torreyi (A. Gray) Benth. ex S. Watson [**UNM**-*Yarnell 90*] D; **J.**
Amaranthus wrightii S. Watson **[-,1,-,-]** D; 8200–9054′; **J;** ms.

Anacardiaceae
Rhus glabra L. **[2,-,3,-]** D, L; 5500–7250′; **J;** mr, ra.
Rhus trilobata Nutt. var. *trilobata* **[35,2,8,15]** D, L, R, S, T; 5600–9580′; **J, G, P, U;** ds, fr, mc, mr, ms, pj, pp, ra.
Toxicodendron rydbergii (Small ex Rydb.) Greene **[7,1,2,-]** D, R; 6300–8500′; **J;** br, mc, mm, mr, ms, pj, pp.

Apiaceae
Aletes acaulis (Torr.) J.M. Coult. & Rose **[8,-,3,-]** D; 5850–7500′; **J, G;** ms, pj, pp.
Angelica pinnata S. Watson **[2,-,-,3]** D, R; 7100–10020′; **J, U;** mm, mr.
Berula erecta (Huds.) Coville var. *incisa* (Torr.) Cronquist **[2,-,3,-]** D, R; 5300–7350′; **J;** fr, mr.
Cicuta maculata L. var. *angustifolia* Hook. **[16,4,3,-]** D, L, R; 5825–8375′; **J;** fr, ml, mm, mr, ra.
Conioselinum scopulorum (A. Gray) J.M. Coult. & Rose **[3,17,1,5]** D, R; 6950–11000′; **J, U;** af, mc, ml, mm, mr, ra.
*•*Conium maculatum* L. **[1,-,-,-]** D; 7490′; **J;** mr.
! *Cymopterus spec. nov.* **[-,-,-,4]** R, T; 6200–8566′; **P, U;** ds, fr, pj.
Cymopterus alpinus A. Gray **[-,3,-,-]** D; 8600–8700′; **J;** mc, mm, sf.
Cymopterus bulbosus A. Nelson **[1,-,1,3]** L, R; 6400–8500′; **J, U;** ms, pg, pj.
Cymopterus constancei R.L. Hartm. **[1,-,1,6]** D, R, S, T; 5550–8500′; **G, P, U;** ds, fr, pg, pj.
Cymopterus glomeratus (Nutt.) A.P. de Candolle var. *fendleri* (A. Gray) R.L. Hartm. **[2,-,1,1]** D, S, T; 5600–7150′; **J, G, P;** ds, pj.
Cymopterus lemmonii (J.M. Coult. & Rose) Dorn **[55,54,3,45]** D, L, R, T; 7300–11150′; **J, P, U;** af, br, mc, mm, mr, ms, pp, ra, sf.
Cymopterus montanus Torr & A. Gray **[1,-,-,-]** D, 7360′; **J;** ds.
♦ *Cymopterus sessiliflorus* (W.L. Theob. & C.C. Tseng) R.L. Hartm. **[-,-,-,2]** R; 6300–7250′; **U;** fr.
Heracleum maximum W. Bartram **[16,4,1,5]** D, R; 6950–11000′; **J, U;** af, mc, ml, mm, mr, sf.
Ligusticum porteri J.M. Coult. & Rose **[9,-,-,5]** D, R; 8180–10900′; **J, U;** af, mc, mm, mr, sf.
!♦*Lomatium grayi* (J.M. Coult.) J.M. Coult. & Rose var. *grayi* [**UNM**-*Heil 8814*] R; **U.**
! *Lomatium triternatum* (Pursh) J.M. Coult. & Rose var. *platycarpum* (Torr.) B. Boivin [**UNM**-*Heil 8793*] R; **U.**
! *Neoparrya lithophila* Mathias **[-,-,-,2]** T; 7900′; **P;** pj.
Osmorhiza chilensis Hook & Arn. **[1,-,-,1]** D, R; 7370–9150′; **J, U;** mm, mr.
Osmorhiza depauperata Phil. **[29,17,5,3]** D, L, R; 6600–10600′; **J, U;** af, br, mc, mm, mr, ms, pp, sf.
Oxypolis fendleri (A. Gray) A. Heller **[22,13,1,10]** D, L, R; 7740–10900′; **J, U;** af, br, mc, ml, mm, mr, sf.
♦ *Podistera eastwoodiae* (J.M. Coult. & Rose) Mathias & Const. **[1,-,-,-]** R; 9300–10135′; **J;** mc.
Sanicula marilandica L. **[-,-,4,-]** L; 7200–7800′; **J;** mr.
! *Sium suave* Walter **[-,-,-,1]** R; 9150′; **J;** mr.

Apocynaceae
Apocynum androsaemifolium L. **[8,2,2,1]** D, L, R; 7250–9100′; **J, U;** mc, mm, mr, ms, pp, ra.
Apocynum cannabinum L. **[7,2,2,-]** D, L; 5500–8300′; **J, G;** fr, mr, ms, pp, ra.
× *Apocynum* ×*floribundum* Greene **[5,-,-,-]** D, R; 6875–8125′; **J;** mr, ra.
[*Apocynum medium* Greene var. *floribundum* (Greene) Woodson]

Araliaceae

Aralia racemosa L. ssp. *bicrenata* (Wooton & Standl.) S.L. Welsh & N.D. Atwood **[3,-,4,-]** D, L, R; 5850–8550'; **J, U;** mc, mm, mr.

Asparagaceae [traditionally in Liliaceae]

* *Asparagus officinalis* L. **[2,-,1,-]** D; 5825–7800'; **J;** fr, mm, ra.

Asclepiadaceae

Asclepias asperula (Decne.) Woodson var. *asperula* **[4,-,5,1]** D, L, S, T; 5600–6320'; **G, P;** ds, fr, pj.

Asclepias engelmanniana Woodson **[-,-,2,-]** D; 5300–6000'; **J;** fr, pj.

Asclepias involucrata Engelmann ex Torr. **[-,-,-,3]** R, T; 6400–7150'; **P, U;** fr, pj.

Asclepias macrosperma Eastw. **[-,-,-,3]** R; 6100–6990'; **P, U;** pj.

Asclepias macrotis Torr. **[1,-,4,-]** L, D; 5300–6600'; **G;** ds, fr, pj.

Asclepias speciosa Torr. **[9,-,1,-]** D, L, R; 5400–8500'; **J, G, P, U;** fr, mm, mr, ra.

Asclepias subverticillata (A. Gray) Vail **[7,1,6,3]** D, L, R; 5300–8450'; **J, G, P, U;** fr, mm, mr, pj, ra.

Asclepias tuberosa L. var. *interior* (Woodson) Shinners **[2,-,4,-]** D, R; 5900–7350'; **J;** mr, pp, ra.

Asclepias viridiflora Raf. **[-,-,3,-]** D, L; 6700–7300'; **J;** pj, pp.

Asteraceae

Achillea millefolium L. **[46,63,6,38]** D, L, R; 6400–11150'; **J, P, U;** af, br, mc, mm, mr, ms, pp, ra, sf.

*•*Acroptilon repens* (L.) DC. **[3,-,1,-]** L, R, T; 5550–8200'; **J, G, P, U;** fr, pp, ra.

Ageratina herbacea (A. Gray) R.M. King & H. Rob. **[-,2,3,1]** D, R; 8625–9220'; **J, U;** mc, ms, pp, ra.

Agoseris aurantiaca (Hook.) Greene var. *purpurea* (A. Gray) Cronquist **[4,29,2,17]** D, R; 8000–11150'; **J, U;** br, mc, mm, mr, ms, pp.

Agoseris glauca (Pursh) Raf. var. *glauca* **[-,9,1,4]** D, R; 7550–11000'; **J, U;** mm, mr, ra.

Agoseris parviflora (Nutt.) Greene **[2,-,-,-]** D, R; 8000–8750'; **J, U;** mm, pp.

Almutaster pauciflorus (Nutt.) Å. Löve & D. Löve **[1,-,-,-]** D; 6320–6340'; **J;** ml.

Amauriopsis dissecta (A. Gray) Rydb. **[2,8,4,3]** D, L, R, T; 7020–9580'; **J, P, U;** mm, mc, pg, pj, pp, ra.

Ambrosia acanthicarpa Hook. **[-,-,3,2]** R, T; 6975–9580'; **J, P, U;** ds, fr, ra.

Ambrosia artemisiifolia L. **[1,-,-,-]** L; 6300'; **G;** ra.

Ambrosia psilostachya DC. **[2,1,-,-]** D, R; 7675–9100'; **J, U;** ml, mm, ra.

Ambrosia tomentosa Nutt. **[2,-,-,-]** D, R; 8050–9200'; **J, U;** mm, ra.

Ambrosia trifida L. var. *trifida* **[-,-,1,-]** D; 5400'; **J;** fr.

Anaphalis margaritacea (L.) Benth. & Hook. **[-,-,2,-]** R; 7150'; **J;** mr.

Antennaria corymbosa E. Nelson **[1,-,-,-]** R; 9300–10135'; **J, U;** mc.

Antennaria marginata Greene **[15,7,4,7]** D, L, R; 6400–10300'; **J, U;** af, mc, mm, mr, pp, sf.

Antennaria microphylla Rydb. **[-,-,-,22]** R; 7450–10900'; **P, U;** af, mc, mm, mr, ms, pp, sf.

Antennaria parvifolia Nutt. **[17,11,3,13]** D, L, R, T; 6400–11150'; **J, P, U;** af, br, mc, mm, mr, ms, pj, pp, sf.

Antennaria rosea Greene **[8,6,1,10]** D, L, R; 6500–10600'; **J, U;** af, mc, mm, mr, pp.
[*Antennaria rosea* subspecies]

Antennaria rosulata Rydb. **[-,4,-,13]** D, R; 7780–10940'; **J, U;** mc, mm, ms, pp.

Aphanostephus ramosissimus DC. var. *humilis* (Benth.) B.L. Turner & Birdsong **[-,-,1,-]** D; 5400'; **J;** fr.

* *Arctium minus* (Hill) Bernh. **[1,-,-,-]** R; 6010–7000'; **J;** mr.

Arnica chamissonis Less. var. *foliosa* (Nutt.) Maguire **[2,1,1,5]** D, R; 5400–9950'; **J, U;** ml, mm, mr, fr.

Arnica cordifolia Hook. **[1,-,-,4]** R; 9300–10150'; **J, U;** mc, mm, mr.

* *Artemisia biennis* Willd. var. *biennis* **[-,-,-,1]** R; 8720–8740'; **U;** ml.

Artemisia bigelovii A. Gray **[1,-,2,-]** D; 5700–7400'; **J;** ds, pj.

Artemisia campestris L. var. *caudata* (Michx.) Palmer & Steyerm. **[-,-,-,2]** R, T; 6820–7000'; **P, U;** fr, pj.

Artemisia campestris L. var. *pacifica* (Nutt.) M. Peck **[6,9,1,5]** D, R, T; 6125–10300'; **J, G, P, U;** mc, mm, mr, pj, pp, ra.

Artemisia carruthii A.W. Wood ex Carruth **[3,22,2,12]** D, L, R, T; 6300–9980'; **J, G, P, U;** ds, mc, mm, ms, pj, pp, ra.

Artemisia dracunculus L. **[-,6,2,11]** D, R, T; 6200–10200'; **J, P, U;** ds, fr, mc, mm, mr, pj, pp, ra.

Artemisia filifolia Torr. **[-,-,3,2]** R, T; 5300–7280'; **J, P, U;** ds, pj.

Artemisia franserioides Greene **[1,13,2,-]** D, L; 7200–9980'; **J;** af, mc, mm, ra.

Artemisia frigida Willd. **[-,5,4,9]** D, R, T; 5850–9850'; **J, P, U;** ds, mc, mm, mr, pg, pj, ra.

Artemisia laciniata Willd. ssp. *parryi* (A. Gray) W.A. Weber **[-,1,-,-]** D; 10340–10875'; **J;** sf.

Artemisia ludoviciana Nutt. var. *albula* (Wooton) Shinners **[-,-,3,2]** D, T; 5600–7736'; **J, P;** ds, pj.

Artemisia ludoviciana Nutt. var. *ludoviciana* **[2,14,3,4]** D, R; 6300–10300'; **J, U;** mc, mm, pj, pp, ra.

Artemisia ludoviciana Nutt. var. *mexicana* (Willd. ex Spreng.) A. Gray **[1,2,5,4]** D, R; 5850–9350'; **J, U;** mc, mm, mr, ms, pj, pp, ra.

Artemisia nova A. Nelson **[-,-,-,4]** R, T; 8300–9020'; **P, U;** ms, pj, pp.

Artemisia tridentata Nutt. var. *tridentata* **[1,-,3,19]** D, R, T; 5500–8950'; **J, P, U;** ds, fr, mm, ms, pj.

Artemisia tridentata Nutt. var. *vaseyana* (Rydb.) B. Boivin **[1,-,-,2]** R; 7500–8700'; **J, U;** ms, pp.

Artemisia tridentata Nutt. var. *wyomingensis* (Beetle & A.M. Young) S.L. Welsh **[-,-,-,3]** R, T; 5400–7350'; **P, U;** fl, pj.

Baccharis salicina Torr. & A. Gray **[3,-,1,-]** D, L; 5400–5900'; **J, G;** fr.

Baccharis wrightii A. Gray **[1,-,-,-]** S; 6320'; **G;** fr.

Baileya multiradiata Harvey & A. Gray ex A. Gray **[-,-,1,-]** D; 6600'; **J;** fr.

Berlandiera lyrata Benth. **[1,-,4,-]** L; 5400–5800'; **G;** fr, ds, pj.

Bidens cernua L. **[-,2,1,-]** D, R; 5360–8600'; **J, U;** mm, mr, fr.

Bidens comosa (A. Gray) Weigand **[-,-,1,-]** D; 5460'; **J;** fr.
[*Bidens tripartita* L.]

Bidens frondosa L. **[-,-,2,-]** D; 5300–5400'; **J;** fr.

Bidens tenuisecta A. Gray **[-,7,-,1]** D, R; 8025–9200'; **J, U;** mm, mr, ms, pp, ra.

Brickellia brachyphylla A. Gray **[1,-,5,1]** D, L, R; 6100–7120'; **J, U;** pj, pp.

Brickellia californica (Torr. & A. Gray) A. Gray **[1,1,1,-]** D; 5800–8625'; **J;** ms, pp.

Brickellia eupatorioides (L.) Shinners var. *chlorolepis* (Wooton & Standl.) B.L. Turner **[-,1,3,1]** D, R; 6300–8800'; **J, U;** fr, mm, ms, pp.

Brickellia grandiflora (Hook.) Nutt. **[1,10,1,-]** D, L, R; 5850–9960'; **J, U;** mc, mm, pp, ra.

Brickellia microphylla (Nutt.) A. Gray var. *scabra* A. Gray **[-,-,-,1]** R; 6300–6600'; **U;** pj.

Brickellia rusbyi A. Gray **[-,1,-,-]** D, R; 8600'; **J, U;** ms.

Brickelliastrum fendleri (A. Gray) King & H.E. Rob. **[4,3,4,3]** D, R; 7950–8700'; **J, U;** mc, mm, mr, ms, pp, ra.

*•*Carduus nutans* L. **[2,2,2,2]** D, R; 7540–9700'; **J, U;** br, mc, mm, pp, ra.

Chaenactis douglasii (Hook.) Hook. & Arn. **[1,-,-,-]** R; 7100'; **J;** pj.

Chaetopappa ericoides (Torr.) G.L. Nesom **[26,-,3,25]** D, L, R, S, T; 5400–9060'; **J, G, P, U;** dg, ds, fr, mm, ms, pg, pj, pp, ra.

Chrysothamnus depressus Nutt. **[-,-,-,4]** R, T; 7185–8655'; **P, U;** mm, pj.

Chrysothamnus greeneii (A. Gray) Greene **[-,-,-,9]** R, T; 8050–8667'; **P, U;** ds, pg, pj, ra.

Chrysothamnus vaseyi (A. Gray) Greene **[-,-,-,4]** R, T; 7800–9020'; **P, U;** ms, pj.

Chrysothamnus viscidiflorus (Hook.) Nutt. var. *lanceolatus* (Nutt.) Greene **[-,-,-,2]** R; 8720–9500'; **U;** mc, ms.

Chrysothamnus viscidiflorus (Hook.) Nutt. var. *viscidiflorus* **[1,-,-,2]** R, T; 6120–9020'; **P, U;** ds, ms, pj.

Cirsium arizonicum (A. Gray) Petrack var. *bipinnatum* (Eastw.) Keil **[2,-,-,-]** D, R; 6250–7330'; **J, U;** ms, pj.

*•*Cirsium arvense* (L.) Scop. **[-,9,1,7]** D, R, T; 5400–11000'; **J, P, U;** fr, mc, ml, mm, mr, ra.

Cirsium neomexicanum A. Gray **[4,3,3,6]** D, R, T; 5860–9000'; **J, G, P, U;** fr, mm, ms, pj, pp, ra.

Cirsium ochrocentrum A. Gray var. *ochrocentrum* **[1,-,-,-]** R; 6300'; **P;** fr.

Cirsium parryi (A. Gray) Petrak **[13,32,1,2]** D, L, R; 6950–10300'; **J, U;** mc, mm, mr, ra, sf.

Cirsium undulatum (Nutt.) Spreng. var. *undulatum* **[4,4,1,-]** D, R; 6875–9580'; **J, U;** fr.

*•*Cirsium vulgare* (Savi) Ten. **[2,10,3,-]** D, L, R; 6013–9800'; **J, U;** af, fr, mm, mr, ra.

* *Conyza canadensis* (L.) Cronquist **[4,7, 6, 1]** D, L, R, S; 6090–9200'; **J, G, P, U;** fr, mm, mr, ms, pp, ra.
[*Conyza canadensis* varieties]

Cosmos parviflorus (Jacq.) Persoon **[-,-,2,-]** L; 7050–7450'; **J;** ra.

Crepis occidentalis Nutt. var. *occidentalis* **[-,-,-,1]** R; 8200–8500'; **U;** ms.

Crepis runcinata (E. James) Torr. & A. Gray var. *barberi* (Greene) B.L. Turner **[1,-,-,-]** D; 8000–8100'; **J;** mm.

Crepis runcinata (E. James) Torr. & A. Gray var. *glauca* (Nutt.) B. Boivin [**UNM**-*Halley 20*] D; **J.**

Crepis runcinata (E. James) Torr. & A. Gray var. *runcinata* **[-,6,-,-]** D; 7550–8710'; **J;** ml, mm, mr.

Cyclachaena xanthifolia (Nutt.) Fresen. **[-,-,3,1]** D, R; 5400–6000'; **J, P;** fr, ra.

Dieteria asteroides Torr. var. *asteroides* **[-,-,3,-]** D, L; 6400–7800'; **J;** pj, pp.

Dieteria bigelovii (A. Gray) Morgan & R.L. Hartm. var. *bigelovii* **[3,11,1,9]** D, L, R, T; 7675–10700'; **J, P, U;** mc, mm, mr, pp, ra.

Dieteria canescens (Pursh) Nutt. var. *ambigua* (B.L. Turner) Morgan & R.L. Hartm. **[2,-,-,-]** L; 5800–6300'; **J, G;** pp, ra.

Dieteria canescens (Pursh) Nutt. var. *aristata* (Eastw.) Morgan & R.L. Hartm. **[-,-,-,9]** R, T; 7300–9550'; **P, U;** mr, ms, pj, pp, ra.

Dieteria canescens (Pursh) Nutt. var. *glabra* (A. Gray) Morgan & R.L. Hartm. **[7,-,-,1]** D, L, R; 6000–9100'; **J, G, P, U;** ds, pj, pp, ml, ra.

Dyssodia papposa (Vent.) Hitchc. **[-,-,1,-]** D; 6000'; **J;** pp.

Ericameria nauseosa (Pall. ex Pursh) G.L. Nesom & G.I. Baird var. *bigelovii* (A. Gray) G.L. Nesom & G.I. Baird **[1,-,-,2]** L, R, T; 6300–8150'; **G, P, U;** ds, pp, ra.

Ericameria nauseosa (Pall. ex Pursh) G.L. Nesom & G.I. Baird var. *graveolens* (Nutt.) Reveal & Schuyler **[-,1,2,7]** D, R, T; 6000–9020'; **J, P, U;** ds, mm, ms, pg, pj, pp, ra.

Ericameria nauseosa (Pall. ex Pursh) G.L. Nesom & G.I. Baird var. *hololeuca* (A. Gray) G.L. Nesom & G.I. Baird **[-,-,-,1]** T; 7600–8655'; **P;** pj.

Ericameria nauseosa (Pall. ex Pursh) G.L. Nesom & G.I. Baird var. *nitida* (L.C. Anderson) G.L. Nesom & G.I. Baird **[-,-,-,1]** R; 6300–6600'; **U;** fr.

Ericameria nauseosa (Pall. ex Pursh) G.L. Nesom & G.I. Baird var. *oreophila* (A. Nelson) G.L. Nesom & G.I. Baird **[-,-,-,11]** R, T; 6200–9200'; **P, U;** ds, fr, mm, pg, pj.

Ericameria parryi (A. Gray) G.L. Nesom var. *attenuata* (M.E. Jones) G.L. Nesom & G.I. Baird **[-,-,2,2]** D, R, S; 6650–9200'; **J, U;** pj, mm.

Ericameria parryi (A. Gray) G.L. Nesom var. *howardii* (Parry ex A. Gray) G.L. Nesom & G.I. Baird **[1,-,-,-]** D; 7000–7400'; **J;** pp.

Ericameria parryi (A. Gray) G.L. Nesom var. *parryi* **[-,-,-,4]** R; 9000–9950'; **U;** af, mm, ra.

Erigeron bellidiastrum Nutt. var. *bellidiastrum* **[1,-,-,4]** R, T; 6000–6975'; **J, P, U;** ds, fr, pj.

Erigeron canus A. Gray **[-,-,1,2]** L, R, T; 5500–8700'; **J, P, U;** pj, ms.

Erigeron concinnus (Hook. & Arn.) Torr. & A. Gray var. *concinnus* **[-,-,1,1]** R; 8950'; **J, U;** fr, mc.

Erigeron coulteri T. Porter **[-,-,-,2]** R; 9100–11000'; **U;** mc, mr.

Erigeron divergens Torr. & A. Gray **[27,24,9,31]** D, L, R, S, T; 5300–10600'; **J, G, P, U;** br, fr, mc, mm, mr, ms, pj, pp, ra, sf.

Erigeron elatior (A. Gray) Greene **[-,-,-,1]** R; 9980–10020'; **U;** mr.

Erigeron eximius Greene **[4,25,1,4]** D, L, R; 8060–10600'; **J, U;** mc, mm, mr, sf.

Erigeron flagellaris A. Gray **[62,52,3,48]** D, R, T; 6500–11150'; **J, P, U;** af, br, mc, mm, mr, ms, pg, pj, pp, ra, sf.

Erigeron formosissimus Greene var. *formosissimus* **[6,48,4,8]** D, R; 7550–11150'; **J, U;** mc, mm, mr, ra, sf.

Erigeron formosissimus Greene var. *viscidus* (Rydb.) Cronquist **[4,14,-,12]** D, L, R; 7800–10940′; **J, U;** mc, mm, mr, ms, pp, ra, sf.

Erigeron grandiflorus Hook. **[1,-,-,1]** R; 9300–10135′; **J, U;** mm, sf.

Erigeron lonchophyllus Hook. **[-,2,-,-]** D; 8620–9850′; **J;** mr, sf.

! *Erigeron nivalis* Nutt. **[-,3,-,-]** D; 10160–10360′; **J;** mm.

Erigeron philadelphicus L. var. *philadelphicus* **[1,-,1,-]** L; 5400–5800′; **G;** fr.

Erigeron pulcherrimus A. Heller **[-,-,-,6]** R; 6050–10900′; **P, U;** ds, pj, pp, mc, mm.

Erigeron pumilis Nutt. var. *pumilis* **[-,-,-,2]** R; 6800–7000′; **U;** ds, ms.

Erigeron speciosus (Lindl.) DC. **[3,7,3,3]** D, L, R; 7150–9400′; **J, U;** br, mc, mm, mr, ms, pj, pp, ra.

Erigeron strigosus Muhl. ex Willd. **[-,-,-,5]** R, T; 6240–7300′; **P, U;** ds, pj.

Erigeron subtrinervis Rydb. ex Porter & Britton **[14,20,2,20]** D, R, T; 6500–10900′; **J, P, U;** af, br, ds, mc, mm, mr, ms, pj, pp, ra.

Erigeron tracyi Greene **[11,1,3,9]** D, L, R, S, T; 5440–9000′; **J, G, P, U;** br, ds, fr, mm, mr, pg, pj, pp.

Erigeron vetensis Rydb. **[-,-,-,15]** R; 7500–10600′; **U;** mc, mm, ms, pp.

Erigeron vreelandii Greene **[1,1,1,1]** D, L, R; 7020–9500′; **J, U;** mc, pp.

Eutrochium maculatum (A. Gray) Breitung var. *bruneri* (A. Gray) E.E. Lamont [**UNM**-*Ivey s.n.*] D; **J.**

Gaillardia aristata Pursh **[2,1,-,-]** D; 7330–8500′; **J;** ms, pp, ra.

Gaillardia pinnatifida Torr. **[9,-,4,3]** D, L, R, S; 5500–8500′; **J, G, P, U;** ds, fr, pg, pj, pp, ra.

Gaillardia pulchella Foug. **[1,-,5,-]** D, L; 6000–6300′; **J, G;** mm, pp.

Gnaphalium exilifolium A. Nelson **[-,14,1,4]** D, R; 7550–9980′; **J, U;** mc, ml, mm, mr, ra.

Gnaphalium palustre Nutt. **[-,-,2,-]** D; 5360′; **J;** fr.

Grindelia arizonica A. Gray **[-,-,-,3]** D, R; 8250–8550′; **J, U;** br, ms, pj.

[*Grindelia arizonica* varieties]

♦ *Grindelia decumbens* Greene var. *subincisa* (Greene) Steyerm. **[1,-,-,2]** D, R; 7200–9150′; **J, U;** ds, mm.

Grindelia squarrosa (Pursh) Dunal **[8,-,3,15]** D, L, R, T; 5760–9500′; **J, G, P, U;** ds, fr, mc, mm, ms, pg, pj, pp, ra.

Gutierrezia sarothrae (Pursh) Britton & Rusby **[6,-,8,41]** D, L, R, T; 5400–9200′; **J, G, P, U;** ds, fr, mm, ms, pg, pj, pp, ra.

Helenium autumnale L. var. *montanum* (Nutt.) Fernald **[-,-,2,-]** D, L; 5400′; **J;** fr.

Helianthella parryi A. Gray **[1,-,-,10]** R; 8280–10940′; **J, U;** af, mc, mm, mr, pp.

Helianthella quinquenervis (Hook.) A. Gray **[-,-,1,2]** D, R; 7850–10000′; **J, U;** br, mm.

Helianthus annuus L. **[3,-,2,5]** D, L, R, T; 6090–8400′; **J, P,U;** ds, ml, pg, pj, ra.

Helianthus nuttallii Torr. & A. Gray **[1,-,-,-]** D; 7675′; **J;** ml.

Helianthus pauciflorus Nutt. var. *subrhomboides* (Rydb.) Cronquist **[2,1,2,1]** D, R; 7025–8625′; **J, U;** br, mr, pp.

Helianthus petiolaris Nutt. var. *fallax* (Heiser) B.L. Turner **[1,-,-,1]** L; 6300′; **G;** mm, ra.

Helianthus petiolaris Nutt. var. *petiolaris* **[2,-,3,1]** D, L, R, S; 5760–6975′; **G, P, U;** ds, fr, pg, pj, ra.

Heliomeris multiflora Nutt. var. *multiflora* **[2,16,5,15]** D, R; 7280–10330′; **J, P, U;** af, br, mc, mm, ms, pp, ra, sf.

Heliomeris multiflora Nutt. var. *nevadensis* (A. Nelson) W.F. Yates **[3,-,-,3]** D, R, T; 7600–9800′; **J, G, P, U;** mc, ms, pj, pp, ra.

Herrickia glauca (Nutt.) Brouillet **[-,-,-,1]** R; 6300–6600′; **U;** fr.

Heterotheca villosa (Pursh) Shinners var. *minor* (Hook.) Semple **[19,19,-,17]** D, L, R, T; 5825–10225′; **J, G, P, U;** af, br, fr, mc, mm, mr, ms, pg, pj, pp, ra, sf.

Heterotheca villosa (Pursh) Shinners var. *nana* (A. Gray) Semple **[12,12,-,23]** D, L, R, T; 5760–9980′; **J, G, P, U;** af, mc, mm, ms, pg, pj, pp, ra.

Heterotheca villosa (Pursh) Shinners var. *pedunculata* (Greene) Harms ex Semple **[-,-,-,2]** R; 9850–10500′; **U;** mm.

Heterotheca villosa (Pursh) Shinners var. *scabra* (Eastw.) Semple **[-,-,-,1]** R; 8200–8350′; **U;** pp.

Heterotheca villosa (Pursh) Shinners var. *villosa* **[19,8,7,15]** D, L, R, S, T; 5470–10600′; **J, G, P, U;** ds, fr, mc, mm, mr, ms, pg, pj, pp, ra.

Hieraceum carneum Greene **[-,-,1,-]** L; 7200′; **J;** pp.

Hieracium fendleri Sch. Bip. **[7,10,2,6]** D, L, R; 7250–11150′; **J, U;** br, mc, ms, pp, ra, sf.

!× *Hieraceum* **×***floribundum* Wimm. & Grab. **[-,-,1,2]** R; 9000–10900′; **J, U;** mm, mr.

Hymenopappus filifolius Hook. var. *cinereus* (Rydb.) I.M. Johnst. **[16,-,10,21]** D, L, R, S, T; 5500–9450′; **J, G, P, U;** ds, fr, mc, mm, ms, pg, pj, pp, ra.

Hymenopappus filifolius Hook. var. *pauciflorus* (I.M. Johnst.) B.L. Turner **[-,-,-,1]** R; 6300–6600′; **U;** fr.

Hymenopappus flavescens A. Gray var. *canotomentosus* A. Gray **[4,-,-,-]** R; 5800–6150′; **J, G, P;** ds, fr, pg, pj.

Hymenopappus newberryi (A. Gray) I.M. Johnst. **[18,17,-,-]** D, R; 7330–10330′; **J;** af, br, mc, mm, mr, ms, pp, ra.

Hymenopappus tenuifolius Pursh **[2,-,-,-]** R, S; 6320–6880′; **G;** ds, pj.

Hymenoxys hoopesii (A. Gray) Bierner **[14,21,3,5]** D, R; 8000–11150′; **J, U;** af, mc, ml, mm, mr, ra, sf.

Hymenoxys richardsonii (Hook.) Cockerell var. *floribunda* (A. Gray) Parker **[31,17,5,51]** D, L, R, T; 5710–9750′; **J, G, P, U;** br, ds, fr, mc, mm, mr, ms, pj, pp, ra.

*Isocoma rusby*i Greene **[-,-,-,2]** R; 6100–6200′; **U;** fr, pj.

Iva axillaris Pursh **[1,1,-,1]** D, R, T; 5400–8200′; **J, G, P;** fr, mm, mr, ra.

Krigia biflora (Walt.) S.F. Blake **[-,2,1,-]** D, L; 7200–8710′; **J;** ml, mm, mr.

! *Lactuca biennis* (Moench) Fernald **[-,-,2,-]** D; 6000–6500′; **J;** mr.

Lactuca canadensis L. [**UNM**-*Clark s.n.*] D, L; **J.**

Lactuca graminifolia Michx. var. *arizonica* McVaugh **[4,4,2,-]** D, L, R; 6300–9140′; **J, P;** fr, mm, mr, ms, ra.

Lactuca pulchella (Pursh) DC. **[2,-,2,-]** D, R; 6000–7100′; **J, U;** mm, mr.

* *Lactuca serriola* L. **[3,2,3,3]** D, L, R, T; 5960–8080′; **J, G, P, U;** br, fr, mm, pj, pp, ra.

Laennecia schiedeana (Less.) G.L. Nesom **[1,6,2,-]** D, L; 8040–9980′; **J;** br, mc, mm, pp, ra.

* *Leucanthemum vulgare* Lam. **[4,6,-,-]** D; 7860–9150'; **J;** mm, mr, ra.

Liatris punctata Hook. var. *punctata* **[1,-,4,-]** D, L; 6500–8200'; **J;** pj, pp.

Lorandersonia baileyi (Wooton & Standl.) Urbatsch, Roberts, & Neubig **[2,-,-,2]** R, T; 6000–6700'; **G, P;** ds, fr, pg, pj.

Lorandersonia linifolia (Greene) Urbatsch, Roberts, & Neubig **[4,-,-,-]** R; 5760–6800'; **J, G;** fr, pg, pj, ra.

+♦*Lorandersonia microcephala* (Cronquist) Urbatsch, Roberts, & Neubig **[-,-,-,3]** R; 8100–8600'; **U;** pp.

Lygodesmia juncea (Pursh) D. Don ex Hook. **[3,-,-,-]** D, R; 6500–7000'; **J;** fr, pj, ra.

Machaeranthera tanacetifolia (Kunth) Nees **[-,-,2,4]** L,R, S, T; 6500–7280'; **J, P, U;** ds, pj.

Madia glomerata Hook. **[-,7,-,10]** D, R, T; 8450–10230'; **J, U;** mc, mm, mr, ra.

Malacothrix fendleri A. Gray **[1,-,2,-]** D, L; 5550–6600'; **G;** fr, pj.

Malacothrix sonchoides (Nutt.) Torr. & A. Gray **[-,-,-,1]** R; 6050–6200'; **U;** ds.

* *Matricaria discoidea* DC. **[4,-,-,-]** D, R; 7490–8850'; **J;** mm, mr, ms, ra.

Melampodium leucanthum Torr. & A. Gray **[1,-,3,-]** D; 5300–6460'; **J, G;** fr, ms, pj.

Oreochrysum parryi (A. Gray) Rydb. **[5,31,2,6]** D, L, R; 6150–11000'; **J, U;** af, mc, mm, mr, pp, ra, sf.

Packera cana (Hook.) W.A. Weber & Å. Löve **[-,1,-,-]** D; 8500'; **J;** pg.

Packera crocata (Rydb.) W.A. Weber & Å Löve **[-,1,-,-]** D, R; **J;** mm.

Packera dimorphophylla (Greene) W.A. Weber & Å Löve var. *dimorphophylla* **[1,-,-,-]** R; 9300–10135'; **J;** mc.

Packera fendleri (A. Gray) W.A. Weber & Å Löve **[14,23,3,-]** D, L, R; 5860–10600'; **J, G;** af, mc, mm, mr, ms, pj, pp, ra, sf.

Packera multilobata (Torr. & A. Gray ex A. Gray) W.A. Weber & Å Löve **[4,-,1,6]** D, R, T; 6300–7700'; **J, P, U;** ds, fr, pg, pj, pp, ra.

Packera neomexicana (A. Gray) W.A. Weber & Å Löve var. *mutabilis* (Greene) W.A. Weber & Å Löve **[21,26,4,18]** D, L, R, T; 6050–9850'; **J, P, U;** af, br, ds, mc, mm, mr, ms, pj, pp, ra, sf.

Packera pseudaurea (Rydb.) W.A. Weber & Å Löve var. *flavula* (Greene) D. Trock & T.M. Barkley **[3,2,2,2]** D, L, R; 7000–9800'; **J, U;** mc, mm, mr, sf.

Packera streptanthifolia (Greene) W.A. Weber & Å Löve **[6,-,-,3]** D, R, T; 6875–10180'; **J, P, U;** af, ds, mr, ms, pp, ra.

Packera thurberi (A. Gray) B.L. Turner **[2-,-,-]** R; 7930–8720'; **J;** af, mm.

Palafoxia sphacelata (Nutt ex Torr.) Cory **[1-,-,-]** R; 5955'; **J;** fr.

Parthenium incanum Kunth **[-,-,1,-]** D; 5800'; **J;** ds.

Pectis angustifolia Torr. var. *angustifolia* **[-,-,3,1]** D, R; 5400–5600'; **J, U;** fr, pj.

Pericome caudata A. Gray **[-,2,3,1]** D, L, R, T; 5850–8580'; **J, P, U;** ds, mc, mr, ra.

Petradoria pumila (Nutt.) Greene var. *pumila* **[1,-,-,6]** D, R, T; 7000–8700'; **J, P, U;** pj, pp.

Pseudognaphalium canescens (DC.) W.A. Weber **[-,-,1,-]** D; 6500'; **J;** pj.

Pseudognaphalium macounii Greene) Kartesz **[1,10,2,-]** D, R, S; 7260–10300'; **J, U;** mc, mm, ms, pp, ra.

Pseudognaphalium stramineum (Kunth) W.A. Weber **[-,-,1,-]** L; 5400'; **J;** fr.

Psilostrophe sparsiflora (A. Gray) A. Nelson [**UNM**-*Castetter 8997*] D; **J.**

Psilostrophe tagetina (Nutt.) Greene **[5,-,4,3]** D, R, S; 5300–7600'; **J, G, U;** ds, fr, pj, pp.

Pyrrhopappus pauciflorus (D. Don) DC. **[-,-,1,-]** L; 5500'; **J;** fr.

Pyrrocoma crocea (A. Gray) Greene var. *crocea* **[1,2,2,3]** D, R; 8675–10600'; **J, U;** af, mm, mr.

Ratibida columnifera (Nutt.) Wooton & Standl. **[6,1,1,1]** D, R, T; 6125–8375'; **J, P, U;** ds, fr, mm, pg, pj, pp, ra.
[*Ratibida columnifera* formas]

Ratibida tagetes (E. James) Barnhart **[1,-,3,1]** D, L; 5400–6100'; **J, G;** fr, pj.

Rudbeckia hirta L. var. *pulcherrima* Farw. **[14,12,2,5]** D, L, R; 7100–10200'; **J, U;** af, mc, mm, mr, ms, ra.

Rudbeckia laciniata L. var. *ampla* (A. Nelson) Cronquist **[22,15,2,2]** D, L, R; 5850–9625'; **J, U;** af, mc, ml, mm, mr, sf.

Sanvitalia abertii A. Gray **[-,-,1,-]** D; 5800'; **J;** pj.

Schkuhria multiflora Hook. & Arn. **[-,3,1,2]** D, T; 6420–8625'; **J, P;** ms, pg, pj, pp, ra.

* *Scorzonera laciniata* L. **[9,1,-,3]** D, R, S; 6200–8750'; **J, G, U;** ds, mm, pg, pj, pp, ra.

Senecio amplectens A. Gray var. *amplectens* **[-,-,-,1]** R; 10700–11000'; **U;** sf.

Senecio atratus Greene **[1,8,1,1]** D, L, R; 8200–11150'; **J, U;** br, mc, sf.

Senecio bigelovii A. Gray var. *hallii* A. Gray **[-,8,3,2]** D, R; 8900–11000'; **J, U;** af, br, mc, mm, mr, ra, sf.

Senecio eremophilus Richardson var. *kingii* (Rydb.) Greenm. **[3,38,1,5]** D, L, R, T; 7150–10300'; **J, P, U;** af, br, mc, mm, mr, ms, pj, pp, ra, sf.
[*Senecio eremophilus* var. *macdougalii* (A. Heller) Cronquist]

Senecio flaccidus Less. var. *flaccidus* **[6,-,2,5]** D, L, R, S, T; 5470–6500'; **J, G, P, U;** fr, mr, pg, pj, ra.

Senecio spartioides Torr. & A. Gray **[1,-,1,7]** D, R, T; 6000–8655'; **J, P, U;** ds, fr, pj, pp.

Senecio triangularis Hook. **[2,-,-,2]** D, R; 8120–11000'; **J, U;** mm, mr.

Senecio wootonii Greene **[14,13,3,3]** D, L, R; 6500–11150'; **J, U;** af, mc, mm, mr, ms, pp, ra, sf.

Solidago altissima L. ssp. *gilvocanescens* (Rydb.) Semple **[-,-,4,4]** D, R, T; 5400–8655'; **J, P, U;** fr, pj, pp.

Solidago lepida DC. var. *salebrosa* (Piper) Semple **[1,-,3,-]** D, L; 5400–7100'; **J, G;** fr, pj.

Solidago missouriensis Nutt. var. *fasciculata* Holzinger **[-,-,-,1]** R; 9700'; **U;** mc.

Solidago missouriensis Nutt. var. *missouriensis* **[2,10,1,2]** D, L, R; 7550–10200'; **J, P, U;** af, mc, mm, mr, pp, ra.

Solidago missouriensis Nutt. var. *tenuissima* (Wooton & Standl.) C. Taylor & J. Taylor **[1,-,-,-]** R; 9100'; **J;** mm.

Solidago mollis Bartl. **[-,-,1,2]** D, R; 6700–8500'; **J, U;** br, ms, pp.

Solidago nana Nutt. **[1,-,-,1]** L, R; 7800–9800'; **J, U;** mc, pp.

Solidago nemoralis Aiton var. *longipetiolata* (Mack. & Bush) Palmer & Steyerm. **[-,2,-,1]** D, R; 8080–8625′; **J, U;** mm, pp, ra.

[*Solidago nemoralis* var. *decemflora* (DC.) Fernald]

Solidago simplex Kunth var. *simplex* **[4,16,3,4]** D, R; 7260–11150′; **J, U;** af, mc, mm, mr, ms, pp, ra, sf.

Solidago speciosa Nutt. var. *pallida* Porter **[-,-,1,-]** L; 7000′; **J;** mr.

Solidago velutina DC. ssp. *sparsiflora* (A. Gray) Semple **[1,1,1,-]** D, L, R; 7200–8160′; **J;** mc, pp, ra.

Solidago wrightii A. Gray var. *adenophora* S.F. Blake **[2,1,2,-]** D, L; 6700–8025′; **J;** pp, mr, ra.

* *Sonchus arvensis* L. ssp. *arvensis* **[1,-,-,-]** L; 5600′; **G;** fr.

* *Sonchus asper* (L.) Hill **[2,1,1,-]** D, L; 5825–8900′; **J, G;** fr, ml, mr, ra.

Stenotus armerioides Nutt. **[-,-,-,4]** R; 6860–8075′; **P, U;** ds, pj.

Stephanomeria exigua Nutt. var. *exigua* **[-,-,-,3]** R, T; 6450–6780′; **P, U;** ds, pj.

Stephanomeria pauciflora (Torr.) A. Nelson **[8,-,4,7]** D, L, R, T; 5600–8655′; **J, G, P, U;** ds, fr, pg, pj, ra.

Symphyotrichum ascendens (Lindl.) G.L. Nesom **[1,21,-,8]** D, R; 7550–10300′; **J, U;** mc, mm, mr, pp, ra.

Symphyotrichum falcatum (Lindl.) G.L. Nesom var. *commutatum* (Torr. & A. Gray) G.L. Nesom **[3,-,1,-]** D, L, R; 6090–7400′; **J, G, P;** br, mr, ra.

Symphyotrichum foliaceum Lindl. ex DC. var. *apricum* (A. Gray) G.L. Nesom **[-,-,-,1]** R; 10230′; **U;** mm.

Symphyotrichum foliaceum (DC.) G.L. Nesom var. *canbyi* (A. Gray) G.L. Nesom **[1,4,-,1]** D, R; 8500–10020′; **J, U;** mm, mr, ra.

Symphyotrichum foliaceum (Lindl. ex DC.) G.L. Nesom var. *parryi* (D.C. Eaton) G.L. Nesom [**UNM**-*Castetter 7891*] R; **U.**

Symphyotrichum laeve (L.) Å. Löve & D. Löve var. *geyeri* (A. Gray) G.L. Nesom **[3,6,3,-]** D, L, R; 6400–8625′; **J, U;** br, ms, pp, ra.

Symphyotrichum lanceolatum (Willd.) G.L. Nesom var. *hesperium* (A. Gray) G.L. Nesom **[-,2,1,1]** D, L, R; 5400–8740′; **J, U;** mm, mr, ms, ra.

Symphyotrichum spathulatum (Lindl.) G.L. Nesom var. *spathulatum* **[-,-,-,4]** R; 8350–10230′; **U;** mm, mr.

* *Tanacetum vulgare* L. **[-,-,-,1]** R, 7300′; **U;** ra.

Taraxacum ceratophorum (Ledeb.) DC. **[-,-,1,-]** L; 7400′; **J;** mr.

* *Taraxacum erythrospermum* Andrz. ex Besser **[8,5,-,2]** D, R; 7360–10230′; **J, U;** mc, mm, mr, ms, pp, ra.

* *Taraxacum officinale* Weber ex F.H. Wigg. **[21,19,1,26]** D, R; 6600–10900′; **J, U;** af, br, mc, mm, mr, ms, pp, ra, sf.

Tetradymia canescens DC. **[-,-,2,6]** D, R, T; 6100–9200′; **J, P, U;** ds, mm, pj.

Tetraneuris acaulis (Pursh) Greene var. *acaulis* **[1,-,-,10]** R, T; 6300–8100′; **P, U;** br, ds, fr, ms, pj.

Tetraneuris argentea (A. Gray) Greene **[13-,10,4]** D, L, R, S, T; 5300–8475′; **J, G, P, U;** br, fr, ms, pg, pj, pp.

Tetraneuris ivesiana Greene **[8,1,-,24]** D, R, T; 7060–9025′; **J, P, U;** fr, ms, mr, pg, pj, pp.

Thelesperma filifolium (Hook.) A. Gray **[2,1,4,2]** D, L, R, S, T; 5900–8800′; **J, G, U;** pj, pp, mm, ra.

Thelesperma megapotamicum (Spreng.) Kuntze **[20,-,6,10]** D, L, R, S, T; 5470–8100′; **J, G, P, U;** ds, fr, mr, ms, pg, pj, pp, ra.

Thymophylla acerosa (DC.) Strother **[1,-,-,-]** L; 5600–6600′; **G;** ds.

Townsendia annua Beaman **[-,-,-,11]** R, T; 6240–7600′; **P, U;** fr, pj.

Townsendia eximia A. Gray **[7,3,4,-]** D, L, R, S; 6140–8625′; **J;** br, mc, mm, mr, ms, pj, pp.

Townsendia exscapa (Richardson) T. Porter **[1,-,2,4]** D, L, R; 5650–8500′; **J, U;** ms, pj, pp.

Townsendia fendleri A. Gray **[3,-,-,8]** R, S, T; 6000–7237′; **J, G, P, U;** ds, fr, pj.

Townsendia incana Nutt. **[-,-,-,5]** R; 6700–8075′; **P, U;** ds, pj.

Townsendia leptotes (A. Gray) Osterh. **[2,-,-,1]** D, T; 6900–7700′; **J, P;** ds, pj, pp.

* *Tragopogon dubius* Scop. **[32,24,3,21]** D, L, R, S, T; 5300–10900′; **J, G, P, U;** af, br, ds, fr, mc, mm, mr, ms, pg, pj, pp, ra, sf.

* *Tragopogon porrifolius* L. **[2,-,-,1]** D, T; 7150–8400′; **J, P, U;** mm, mr, ra.

* *Tragopogon pratensis* L. **[5,-,-,1]** D, R, T; 5760–9100′; **J, G, P, U;** ds, mc, mr, ms, pp, ra.

Verbesina encelioides (Cav.) Benth. & Hook. f. ex A. Gray **[1,-,2,10]** D, R, S, T; 5400–8655′; **G, U;** ds, fr, ml, pj, ra.

[*Verbesina encelioides* var. *exauriculata* B.L. Rob.]

Wyethia arizonica A. Gray **[2,-,-,2]** R; 7800–8750′; **J, U;** mm, ms, pj, pp.

Xanthisma gracile (Nutt.) Morgan & R.L. Hartm. **[2,-,2,3]** D, L, R, T; 5700–8600′; **J, G, P, U;** ds, fr, mm, pg, pj, pp, ra.

Xanthisma grindelioides (Nutt.) Morgan & R.L. Hartm. var. *grindelioides* **[-,-,-,2]** R; 6750–7000′; **U;** pj.

Xanthisma spinulosum (Pursh) Morgan & R.L. Hartm. var. *spinulosum* **[14,-,5,28]** D, L, R, S, T; 5500–10200′; **J, G, P, U;** ds, fr, mm, pg, pj, pp, ra.

Xanthium strumarium L. var. *canadense* (Mill.) Torr. & A. Gray **[2,-,2,3]** D, L, R; 6000–7100′; **J, P, U;** fr, ra.

Zinnia grandiflora Nutt. **[-,-,1,-]** D; 6100′; **J;** pj.

Berberidaceae

Berberis fendleri A. Gray **[30,5,5,14]** D, L, R, T; 6100–9025′; **J, P, U;** af, br, mc, mm, mr, ms, pj, pp, ra.

Berberis repens Lindl. **[30,12,2,11]** D, L, R; 6800–9625′; **J, U;** af, br, mc, mm, mr, ms, pp.

Betulaceae

Alnus incana (L.) Moench var. *occidentalis* (Dippel) C.L. Hitchc. **[24,9,2,12]** D, L, R; 6875–10900′; **J, U;** ml, mm, mr, ra.

[*Alnus incana* ssp. *tenuifolia* (Nutt.) Breitung]

Alnus oblongifolia Torr. **[1,-,1,-]** D; 6200–7675′; **J;** ml, mr.

! *Betula glandulosa* Michx. **[-,2,-,-]** D; 8460–9200′; **J;** ml, mr.

Betula occidentalis Hook. **[3,4,5,1]** D, L, R; 6700–8075′; **J, U;** fr, mm, mr, ra.

Boraginaceae

Cryptantha cinerea (Greene) Cronquist var. *cinerea* **[13,1,5,18]** D, L, R, S, T; 5860–8080′; **J, G, P, U;** ds, fr, mm, ms, pg, pj, pp, ra.

Cryptantha cinerea (Greene) Cronquist var. *jamesii* Cronquist **[9,-,5,-]** D, L, R; 5800–8250′; **J, G, P;** br, fr, pj, pp, ra.

Cryptantha crassisepala (Torr. & A. Gray) Greene var. *elachantha*

I. M. Johnst. **[1,-,1,9]** D, L, R, T; 5460–9200′; **G, P, U;** ds, fr, mr, pj, ra.

Cryptantha fendleri (A. Gray) Greene **[1,-,-,10]** L, R, T; 6300′; **G, P, U;** pp, ra.

Cryptantha flava (A. Nelson) Payson **[2,-,-,-]** D, R; 5860–7660′; **J, G;** ms, pj.

Cryptantha fulvocanescens (S. Watson) Payson var. *fulvocanescens* **[-,-,-,6]** R, T; 6050–7050′; **J, P, U;** ds, fr, pj.

Cryptantha minima Rydb. **[2,-,-,3]** R, S, T; 6320–7200′; **G, P, U;** ds, fr, pj.

Hackelia besseyi (Rydb.) J.L. Gentry **[-,6,1,-]** D; 8100–9580′; **J;** mc, ml, mm, mr, pp.

Hackelia floribunda (Lehm.) I.M. Johnst. **[9,6,4,2]** D, L, R; 6400–9800′; **J, U;** mc, mm, mr, ra.

+♦*Hackelia hirsuta* (Wooton & Standl.) I.M. Johnst. **[-,-,1,-]** L; 8100′; **J;** mc.

Lappula occidentalis (S. Watson) Greene var. *cupulata* (A. Gray) L.C. Higgins **[3,-,1,2]** D, R, S, T; 5860–7100′; **J, G, P, U;** ds, fr, pg, pj.

Lappula occidentalis (S. Watson) Greene var. *occidentalis* **[31,20,4,48]** D, L, R, S, T; 5550–10050′; **J, G, P, U;** af, br, fr, mc, ml, mm, ms, pg, pj, pp, ra.

Lithospermum cobrense Greene [**UNM**-*Castetter 10732*] D; **J.**

Lithospermum incisum Lehm. **[7,-,3,17]** D, L, R, T; 6100–8655′; **J, G, P, U;** fr, mc, mm, pj, pp, ra.

Lithospermum multiflorum Torr. ex A. Gray **[35,19,6,8]** D, L, R, T; 6300–9580′; **J, P, U;** af, br, mc, mm, mr, ms, pj, pp, ra.

Mertensia ciliata (James ex Torr.) G. Don **[-,-,-,2]** R; 9300–11000′; **U;** mr.

Mertensia franciscana A. Heller **[28,8,4,5]** D, L, R; 6400–10900′; **J, U;** af, mc, mm, mr, ra, sf.

Mertensia lanceolata (Pursh) DC. **[30,15,3,13]** D, L, R; 6300–10940′; **J, U;** af, br, mc, mm, mr. ms, pj, pp, sf.
[*Mertensia lanceolata* varieties]

Plagiobothrys scouleri (Hook. & Arn.) I.M. Johnst. var. *hispidulus* (Greene) Dorn **[-,2,2,5]** D, R; 7550–9540′; **J, U;** ml, mm, mr.

Brassicaceae

* *Alyssum simplex* Rudolphi **[4,-,-,17]** D, R, T; 6850–8500′; **J, P, U;** br, mm, mr, ms, pj, pp, ra.

Arabis hirsuta (L.) Scop. var. *pycnocarpa* (M. Hopkins) Rollins **[4,3,1,-]** D, R; 8060–9140′; **J;** mc, mm, mr, ms.

* *Barbarea vulgaris* R. Br. **[-,-,1,1]** D, R; 6200–8000′; **J, U;** mr, ra

* *Berteroa incana* (L.) DC. **[-,2,-,-]** D; 8200–8400′; **J;** mm, ra.

× *Boechera* ×*divaricarpa* (A. Nelson) Å. Löve & D. Löve **[3,4,-,13]** D, R, T; 7150–10600′; **J, P, U;** br, mc, mm, mr, ms, pp, ra.
[Our plants are an unnamed hybrid *B. fendleri* × *B. stricta*.]

Boechera fendleri (S. Watson) W.A. Weber **[5,5,3,12]** D, L, R; 5600–10150′; **J, P, U;** mc, mm, ms, pj, pp, ra.

Boechera lignifera (A. Nelson) W.A. Weber **[-,-,-,3]** R; 6500–7237′; **U;** pj.

Boechera pallidifolia (Rollins) W.A. Weber **[-,-,-,7]** R, T; 6050–8075′; **P, U;** ds, fr, pj.

Boechera perennans (S. Watson) W.A. Weber **[1,2,-,-]** D, R; 8000–10650′; **J, U;** mc, pp, ra.

Boechera retrofracta (Graham) Å. Löve & D. Löve **[-,-,-,2]** R; 7560–7950′; **U;** pj, pp.
[*Boechera holboellii* (Hornem.) Å. Löve & D. Löve]

Boechera spatifolia (Rydb.) Windham & Al-Shehbaz **[-,-,-,12]** R, T; 7500–9500′; **P, U;** ds, mc, pj, pp.

Boechera stricta (Graham) Al-Shehbaz **[14,49,1,15]** D, R; 7310–10300′; **J, U;** af, mc, mm, mr, ms, pp, ra, sf.

* *Camelina microcarpa* Andrz. ex DC. **[3,-,-,4]** D, R, S; 5440–9200′; **J, G, U;** ds, fr, pg, pp, ra.

* *Capsella bursa-pastoris* (L.) Medik. **[21,19,2,11]** D, R; 7310–10050′; **J, U;** af, br, mc, mm, mr, ms, pp, ra.

Cardamine cordifolia A. Gray var. *cordifolia* **[8,5,1,3]** D, R; 6800–10000′; **J, U;** af, mc, mm, mr, sf.

! *Cardamine cordifolia* A. Gray var. *incana* A. Gray ex M.E. Jones **[1,-,-,-]** R; 9300–10000′; **J;** mr.

* *Chorispora tenella* (Pall.) DC. **[2,-,1,-]** D, L, R; 6000–9000′; **J, U;** br, mr, ra.

* *Conringia orientalis* (L.) Dumort. **[1,-,-,-]** D; 7360′; **J;** ra.

Descurainia californica (A. Gray) O.E. Schulz **[-,-,-,5]** R; 8760–9540′; **U;** af. mm, mr.

Descurainia incana (Bernh. ex Fisch. & C.A. Mey.) Dorn ssp. *incisa* (Engelm.) Kartesz & Gandhi **[2,1,3,6]** D, R, T; 5400–10700′; **J, U;** br, fr, mm, mr, pj, pp, sf.
[*Descurainia incisa* (Engelm. ex A. Gray) Britton ssp. *incisa*]

Descurainia incana (Bernh. ex Fisch. & C.A. Mey.) Dorn var. *macrosperma* (O.E. Schulz) Dorn **[1,13,1,1]** D, R; 8625–11000′; **J, U;** mc, mm, mr, ra, sf.
[*Descurainia incana*]

Descurainia incana (Bernh. ex Fisch. & C.A. Mey.) Dorn var. *viscosa* (Rydb.) Dorn **[1,9,1,4]** D, L, R, T; 6200–9980′; **J, P, U;** af, br, fr, mc, mm, mr, pj, pp, ra, sf.
[*Descurainia incisa* (Engelm. ex A. Gray) Britton ssp. *viscosa* (Rydb.) Rollins]

Descurainia pinnata (Walter) Britton var. *filipes* (A. Gray) Peck **[-,-,-,2]** R; 7700–10150′; **U;** br, mm.
[*Descurainia incisa* (Engelm. ex A. Gray] ssp. *filipes* (A. Gray) Rollins]

Descurainia pinnata (Walter) Britton var. *osmiarum* (Cockerell) Shinners **[6,-,2,10]** D, R, S, T; 5860–10100′; **J, G, P, U;** ds, fr, mc, pg, pj, ra.
[*Descurainia pinnata* ssp. *halictorum* (Cockerell) Detling]

! *Descurainia pinnata* (Walter) Britton var. *paysonii* Detling **[-,-,-,1]** R; 6050–9200′; **U;** ds, mm.
[*Descurainia incisa* (Engelm. ex A. Gray) Britton ssp. *paysonii* (Detling) Rollins]

* *Descurainia sophia* (L.) Webb ex Prantl **[16,9,2,17]** D, L, R, T; 5550–9500′; **J, G, P, U;** br, fr, mc, mm, mr, pg, pj, pp, ra.

Dimorphocarpa wislizeni (Engelm.) Rollins **[9,-,4,10]** D, R, S, T; 5470–7220′; **J, G, P, U;** ds, fr, pg, pj, ra.

Draba aurea Vahl ex Hornem. **[1,17,-,-]** D, R; 8060–10300′; **J, U;** mc, mm, mr, ra, sf.

Draba helleriana Greene var. *helleriana* **[9,33,4,2]** D, L, R; 7500–11150′; **J, U;** br, mc, mm, mr, pp, sf.

Draba helleriana Greene var. *patens* (Heller) O.E. Schulz **[5,-,-,-]** D, R; 6800–9625′; **J;** mc.

Draba rectifructa C.L. Hitchc. **[1,-,-,3]** R; 8840–10150′; **J, U;** mc, mm, mr.

Draba reptans (Lam.) Fernald **[-,-,1,2]** R; 6250–7740′; **J, U;** pj.
Draba streptocarpa A. Gray **[-,-,-,5]** R; 7050–9200′; **U;** mc, ml, ms, pj.
Erysimum capitatum (Douglas ex Hook.) Greene var. *capitatum* **[4,9,3,2]** D, L, R, T; 6400–10225′; **J, P, U;** br, fr, mm, mr, ms, pj, pp, ra.
Erysimum capitatum (Douglas ex Hook.) Greene var. *elatum* (Nuttall) Torr. **[18,11,-,30]** D, L, R, S, T; 5860–11150′; **J, G, P, U;** br, ds, fr, mc, mm, mr, ms, pg, pj, pp, ra, sf.
* *Erysimum cheiranthoides* L. [**UNM**-*Yarnell 34*] R; **U.**
Erysimum inconspicuum (S. Watson) MacMillan **[-,-,-,3]** R, T; 7300–8560′; **P, U;** ds, pj.
* *Erysimum repandum* L. **[1,-,-,-]** D; 7360′; **J;** ra.
Hesperidanthus linearifolia (A. Gray) Rydb. **[21,2,3,24]** D, L, R, T; 5860–8940′; **J, G, P, U;** br, fr, mc, mm, mr, ms, pj, pp, ra.
Lepidium alyssoides A. Gray var. *alyssoides* **[3,-,-,11]** D, R, T; 6200–8400′; **J, P, U;** ds, fr, pg, pj, ra.
Lepidium alyssoides A. Gray var. *eastwoodiae* (Wooton) Rollins **[3,-,-,-]** R; 6500–8475′; **J;** fr, pj, ra.
* *Lepidium appelianum* Al-Shehbaz **[-,-,-,1]** R; 8000–8400′; **P;** ra.
* *Lepidium chalapense* L. **[2,-,-,1]** D, R, T; 6000–8200′; **J, P;** ra.
Lepidium densiflorum Schrad. var. *densiflorum* **[8,-,1,2]** D, L, R; 5550–9100′; **J, G, U;** fr, mm, ms, pg, pj, pp, ra.
Lepidium densiflorum Schrad. var. *macrocarpum* G.A. Mulligan **[-,-,-,1]** R; 9300–9500′; **U;** mc.
Lepidium densiflorum Schrad. var. *ramosum* (A. Nelson) Thell. **[7,-,-,-]** D, L, R, S; 6140–9625′; **J;** br, mm, mr, pp, ra.
* *Lepidium draba* L. **[-,-,3,-]** D, L; 6000–7600′; **J;** ra.
*•*Lepidium latifolium* L. **[2,-,1,-]** D, L, R; 5400–5600′; **G;** fr, ra.
! *Lepidium ramosissimum* A. Nelson var. *bourgeauanum* (Thell.) Rollins **[-,20,-,5]** D, R, T; 7950–9850′; **J, P, U;** af, mc, mm, mr, ms, pj, pp, ra.
Lepidium ramosissimum A. Nelson var. *ramosissimum* **[-,-,-,1]** R; 9250′; **U;** mr.
Lepidium virginicum L. var. *medium* (Greene) C.L. Hitchc. **[2,-,2,5]** D, R, S, T; 5500–8500′; **G, U;** br, fr, pj, ra.
Lepidium virginicum L. var. *pubescens* (Greene) Thell. **[4,21,-,4]** D, R, T; 7550–10230′; **J, P, U;** mc, ml, mm, mr, pp, ra.
* *Nasturtium officinale* R. Br. **[9,2,1,-]** D, L, R; 5360–8625′; **J, G, U;** fr, mm, mr, ra.
Noccaea fendleri (A. Gray) Holub ssp. *glauca* (A. Nelson) Al-Shebaz & M. Koch **[18,11,2,13]** D, L, R; 6700–10600′; **J, U;** af, mc, mm, mr, pp, ra, sf.
Pennellia longifolia (Benth.) Rollins **[2,10,-,-]** D, L; 7120–10300′; **J;** mc, ms, pp, ra.
Pennellia micrantha (A. Gray) Nieuwl. **[-,1,-,1]** D, R; 8300–9000′; **J, U;** af, pp.
Physaria fendleri (A. Gray) O'Kane & Al-Shehbaz **[2,-,1,6]** D, R; 5700–7600′; **J, G, U;** ds, fr, pj.
Physaria floribunda Rydb. var. *floribunda* [**UNM**-*Atwood 21221*] R; **U.**
Physaria intermedia (S. Watson) A. Heller [**UNM**-*Tonne s.n.*] D; **U.**
Physaria montana (A. Gray) Greene **[1,-,-,10]** R, T; 6400–8655′; **J, P, U;** fr, ms. pj, ra.
Physaria rectipes (Wooten & Standl.) O'Kane & Al-Shehbaz **[10,-,1,12]** D, L, R, S, T; 5600–8500′; **J, G, P, U;** ds, fr, ms, pg, pj, pp.
Rorippa curvipes Greene var. *curvipes* **[1,-,-,4]** D, R; 8300–10230′; **J, U;** mr.
Rorippa curvipes Greene var. *truncata* (Jeps.) Rollins **[-,-,1,-]** D; 5400–5900′; **J;** fr.
Rorippa palustris (L.) Besser var. *fernaldiana* (Butters & Abbe) Stuckey **[2,-,2,-]** D, R; 5360–8980′; **J;** fr, mr.
Rorippa palustris (L.) Besser var. *hispida* (Desv.) Jonsell **[-,-,1,-]** D; 5360′; **J;** fr.
Rorippa sinuata (Nutt.) Hitchc. **[-,-,1,-]** D; 5360′; **J;** fr.
Rorippa sphaerocarpa (A. Gray) Britton **[1,16,-,-]** D, R; 8450–10300′; **J, U;** mm, mr, ms, pp.
* *Sisymbrium altissimum* L. **[11,1,4,10]** D, L, R, S, T; 5470–8500′; **J, G, P, U;** ds, fr, ml, pj, ra.
* *Sisymbrium loeselii* L. **[-,1,-,1]** D, R; 8000–8400′; **J, P;** mm, ra.
Stanleya pinnata (Pursh) Britton var. *pinnata* **[-,-,-,1]** R; 8250′; **U;** pj.
Streptanthella longirostris (S. Watson) Rydb. **[1,-,1,3]** R; 6000–6500′; **J, U;** fr, ra.
Streptanthus cordatus Nutt. var. *cordatus* **[1,-,1,2]** D, R; 6400–8075′; **J, P, U;** pj, pp.
Thelypodiopsis purpusii (Brandegee) Rollins **[1,-,7, -]** S; 5800–6500′; **J, G;** fr, pj.
Thelypodium integrifolium (Nutt.) Endl. ex Walp. var. *gracilipes* B.L. Rob. **[-,1,-, -]** D; 9500–9660′; **J;** mc.
Thelypodium wrightii A. Gray subsp. *wrightii* **[3,-,1,-]** D, L, R; 6250–7120′; **J, G, U;** pj, pp, ra.
* *Thlaspi arvense* L. **[-,-,-,1]** R; 7540–7740′; **U;** ms.
Turritis glabra L. **[8,8,5,-]** D, L, R; 6400–9450′; **J, U;** af, br, mm, mr, ms, pp, ra.

Cactaceae

Coryphantha vivipara (Nutt.) Britton & Rose **[1,-,1,9]** D, R, T; 5600–9450′; **J, P, U;** fr, mc, pp.
Cylindropuntia imbricata (Haw.) Knuth var. *imbricata* **[7,-,1,15]** D, R, S, T; 5900–8000′; **J, G, P, U;** fr, ms, pj, pp, ra.
Echinocereus coccineus Engelm. **[3,2,2,6]** D, L. R, T; 6400–8670′; **J, P, U;** ds, ms, pj, pp, ra.
Echinocereus fendleri (Engelm.) F. Seitz **[3,-,1-]** D, L, S; 5440–5940′; **G;** ds, fr, pj.
Echinocereus triglochidiatus Engelm. **[4,-,1,16]** D, R, T; 5800–9450′; **J, G, P, U;** ds, fr, pj, pp.
Echinocereus viridiflorus Engelm. **[1,-,1,12]** L, R; 6500–9000′; **J, P, U;** ds, fr, mc, pg, pj, pp.
+ *Grusonia clavata* (Engelm.) H. Rob. **[1,-,-,-]** S; 6320′; **G;** ds.
Opuntia fragilis Nutt. [**UNM**-*Reenea 2146*] R; **U.**
Opuntia macrorhiza Engelm. [**RM**-*Nelson 228*] D; **J.**
Opuntia phaeacantha Engelm. **[10,1,2,13]** D, L, R, T; 5600–8670′; **J, G, P, U;** ds, fr, mc, pj, pp, ra.
Opuntia polyacantha Haw. var. *hystricina* (Engelm. & Bigelow) B.D. Parfitt **[1,-,1,-]** D, R; 6000′; **J;** pj.
Opuntia polyacantha Haw. var. *polyacantha* **[8,-,1,28]** D, L, R, S, T; 5440–8700′; **J, G, P, U;** ds, fr, ms, pg, pj, pp.
Pediocactus simpsonii (Engelm.) Britton & Rose [**UNM**-*Castetter 1002 A-J*] R; **U.**
Sclerocactus papyracanthus (Engelm.) N.P. Taylor **[-,-,1,-]** L; 6300′; **J;** pj.

Campanulaceae

Campanula parryi A. Gray var. *parryi* **[5,14,2,5]** D, R; 8000–10230′; **J, U;** mm, mr.

Campanula rotundifolia L. **[27,40,7,20]** D, L, R; 5850–11150′; **J, U;** af, br, mc, mm, mr, ms, pp, ra, sf.

Lobelia cardinalis L. **[1,-,2,-]** D, L; 5300–5400′; **J;** ml, mr.

Cannabaceae

Celtis reticulata Torr. **[3,-,3,-]** D, L, S; 5400–6000′; **J, G;** fr, mr, pj.

Humulus lupulus L. var. *neomexicanus* A. Nelson & Cockerell **[7,3,2,-]** D, R; 5550–8750′; **J;** mc, mm, mr, ms, ra.

Caprifoliaceae (includes Valerianaceae)

Linnaea borealis L. var. *longiflora* Torr. **[3,3,1,-]** D, L, R; 8475–9950′; **J;** mc, mr.

Lonicera involucrata (Richardson) Banks ex Spreng. **[19,5,1,2]** D, L, R; 7500–10260′; **J, U;** af, mc, mm, mr, sf.

Symphoricarpos rotundifolius A. Gray **[18,3,3,32]** D, L, R; 7100–10900′; **J, P, U;** af, mc, mm, mr, ms, pp, sf.

Valeriana acutiloba Rydb. var. *acutiloba* **[11,2,1,-]** D, L, R; 8000–9300′; **J, P, U;** af, mc, mm, mr.

Valeriana arizonica A. Gray **[3,-,-,-]** D; 7525–8600′; **J;** af, br, mr, pp.

Valeriana edulis Nutt. ex Torr. & A. Gray **[17,3,2,-]** D, R; 7600–9800′; **J;** mc, mm, mr, ms, pp.

Caryophyllaceae

Arenaria lanuginosa (Michx.) Rohrb. var. *saxosa* (A. Gray) Zarucchi, R.L. Hartm., & Rabeler **[10,36,3,6]** D, L, R; 7850–11150′; **J, U;** af, br, mc, mm, mr, ms, pp, sf.
[*Spergulastrum lanuginosum* Michx. ssp. *saxosum* (A. Gray) W. A. Weber]

Cerastium arvense L. var. *strictum* (Gaudin) Koch **[14,20,5,3]** D, L, R; 6850–10600′; **J, U;** af, br, mc, mm, mr, ms, ra, sf.

Cerastium brachypodum (Engelm. ex A. Gray) B.L Rob. **[-,2,-,-]** D; 8570–9725′; **J;** mm, mr.

Cerastium fastigiatum Greene [**UNM**-*Sivinski 5826*] R; **U.**

* *Cerastium fontanum* Baumg. subsp. *vulgare* (Hartm.) Greuter & Burdet **[3,17,1,2]** D, R; 6100–10230′; **J, G, U;** mc, ml, mm, mr, ms.

* *Dianthus armeria* L. subsp. *armeria* **[-,2,-,-]** D; 8075–8625′; **J;** pp, ra.

Drymaria effusa A. Gray var. *depressa* (Greene) Duke **[-,-,-,2]** R; 8200–8600′; **U;** pp.

Drymaria glandulosa Bartling var. *glandulosa* **[-,-,-,1]** R; 6990′; **U;** pj.

Drymaria leptophylla (Cham. & Schltdl.) Fenzl ex Rohrbach var. *leptophylla* **[-,-,-,1]** R; 8200–8350′; **U;** pp.

Drymaria molluginea (Seringe) Didr. **[-,1,2,1]** D, R; 6500–8670′; **J, U;** br, pj, ra.

Eremogone eastwoodiae (Rydb.) Ikonn. var. *adenophora* (Kearney & Peebles) R.L. Hartm. & Rabeler **[-,-,-,2]** R; 6200–6500′; **U;** fr.

Eremogone eastwoodiae (Rydb.) Ikonn. var. *eastwoodiae* **[1,-,-,3]** R; 6050–6500′; **P, U;** ds, fr, pj.

Eremogone fendleri (A. Gray) Ikonn. **[7,38,1,9]** D, R; 7860–11150′; **J, U;** mc, mm, mr, pp, ra, sf.

Moehringia lateriflora (L.) Fenzl **[-,-,-,1]** R; 9250′; **U;** mr.

Moehringia macrophylla (Hook.) Fenzl **[1,-,2,-]** D, L; 6300–8900′; **J;** br, mr.

Pseudostellaria jamesiana (Torr.) W.A. Weber & R.L. Hartm. **[13,6,-,5]** D, R; 7300–10150′; **J, U;** af, mc, mm, mr, ms, pp, ra, sf.

Sagina saginoides (L.) H. Karst. **[2,-,-,1]** D, R; 8460–9720′; **J, U;** mc, mm, mr.

* *Saponaria officinalis* L. **[-,-,1,-]** D; 6000′; **J;** mr.

Silene antirrhina L. **[1,-,4,-]** D; 5700–6020′; **J, G;** fr.

Silene drummondii Hook. var. *drummondii* **[5,19,-,11]** D, R; 7800–10900′; **J, U;** af, mc, mm, mr, ms, pp, ra, sf.

! *Silene drummondii* Hook. var. *striata* (Rydb.) Bocq. **[-,-,-,4]** R; 9300–10940′; **U;** mm, mr.

Silene menziesii Hook. **[6,1,-,2]** D, R; 7950–9000′; **J, U;** mc, mr, ms, pp.

Silene scouleri Hook. var. *pringlei* (S. Watson) C.L. Hitchc. & Maguire ex Kartesz & Gandhi **[1,20,2,2]** D, R; 7025–10325′; **J, U;** af, mc, mm, mr, pp, ra.

* *Spergularia rubra* (L.) J. Presl & C. Presl **[1,-,-,-]** R; 9200–9400′; **J;** ra.

Spergularia salina J. Presl & C. Presl **[-,-,1,-]** D; 5360′; **J;** mr.

Stellaria calycantha (Ledeb.) Bong. **[-,1,-,-]** D; 9680–10340′; **J;** mr.
[*Stellaria calycantha* var. *simcoei* (Howell) Fernald]

Stellaria longifolia Muhl. ex Willd. **[3,3,-,1]** D, R; 7740–9100′; **J, U;** mm, mr, pp.

Stellaria longipes Goldie var. *longipes* **[3,9,-,5]** D, R; 8525–10150′; **J, U;** af, mc, mm, mr, sf.

* *Stellaria media* (L.) Villars **[-,-,1,-]** L; 7100′; **J;** mr.

Stellaria umbellata Turcz. ex Karel. & Kir. **[-,1,-,-]** R; 9200–10300′; **J;** mr.

Celastraceae

Paxistima myrsinites (Pursh) Raf. **[31,33,3,14]** D, L, R, T; 6200–10700′; **J, P, U;** af, br, mc, mm, mr, ms, pp, sf.

Chenopodiaceae

Atriplex argentea Nutt. var. *argentea* [**UNM**-Castetter 3929] D; **J.**

Atriplex canescens (Pursh) Nutt. var. *canescens* **[14,-,5,24]** D, L, R, S, T; 5470–8560′; **J, G, P, U;** ds, fr, mr, ms, pg, pj, ra.

Atriplex confertifolia (Torr. & Frem.) S. Watson **[2,-,-,-]** D, R; 7000–7100′; **J;** ds, pj.

* *Bassia hyssopifolia* (Pall.) Kuntze **[-,-,-,4]** D, R, T; 8440–10700′; **P, U;** ds, mr, mm.

Chenopodium atrovirens Rydb. **[-,9,-,5]** D, R; 6975–10100′; **J, U;** mc, mm, mr, ms, pp, ra.

Chenopodium berlandieri Moq. var. *zschackei* (Murr) Murr ex Asch. **[3,2,1,-]** D, R; 5400–9625′; **J;** mc, mm, ms, pp, ra, sf.

!* *Chenopodium capitatum* (L.) Asch. **[-,1,-,-]** D; 9500–10120′; **J;** mc.

Chenopodium desiccatum A. Nelson **[-,-,-,3]** D, T; 8440–8450′; **P;** ml.

Chenopodium fremontii S. Watson **[3,17,5,12]** D, L, R, T; 6000–9800′; **J, P, U;** mc, mm, mr, pp, ra.

* *Chenopodium glaucum* L. var. *glaucum* **[-,-,1,-]** T; 5400′; **J;** fr.

Chenopodium hians Standl. **[-,-,-,2]** R, T; 6600–8655′; **P, U;** pj.

Chenopodium incanum (S. Watson) A. Heller var. *incanum* **[3,-,2,3]** D, L, S, T; 5550–8667′; **J, G; P;** ds, fr, mm, ms, pj.

Chenopodium leptophyllum (Moq.) Nutt. ex S. Watson **[-,2,1,3]** D, R; 6480–8400′; **J, U;** ms, pp, ra.
Chenopodium neomexicanum Standl. [**UNM-***Fleck s.n.*] R; **J.**
* *Chenopodium overi* Aellen **[8,15,2,2]** D, R; 7450–9800′; **J, U;** af, br, mc, ml, mm, mr, ms, ra, sf.
[*Chenopodium capitatum* var. *parvicapitatum* S.L. Welsh]
Chenopodium pratericola Rydb. **[4,2,2,3]** D, L, R, T; 5450–9500′; **J, G, P, U;** fr, mm, mr, pg, ra.
[Chenopodium desiccatum A. Nelson var. leptophylloides (Murr) Wahl]
* *Chenopodium rubrum* L. var. *rubrum* **[-,-,1,-]** D; 5400′; **J;** fr.
Chenopodium watsonii A. Nelson **[-,-,-,2]** R; 6550–8150′; **P, U;** ds, pj.
* *Dysphania ambrosioides* (L.) Mosyakin & Clemants **[-,-,1,-]** D; 5400′; **J;** fr.
* *Dysphania botrys* (L.) Mosyakin & Clemants **[-,-,1,-]** D; 5400′; **J;** fr.
Dysphania graveolens (Willd.) Mosyakin & Clemants **[-,6,6,13]** D, R, S, T; 6500–9340′; **J, P, U;** br, ds, fr, mc, ms, pg, pj, pp, ra.
* *Kochia scoparia* (L.) Schrad. **[1,1,1,5]** D, R, T; 5200–8900′; **J, P, U;** fr, pg, pj, ra.
Krascheninnikovia lanata (Pursh) Meeuse & Smit **[2,-,1,11]** D, R, T; 6100–8320′; **J, P, U;** ds, pg, pj, ra.
Monolepis nuttalliana (Schult.) Greene **[1,8,-,7]** D, R, T; 7900–9600′; **J, P, U;** mm, mr, ra.
* *Salsola tragus* L. **[3,-,3,16]** D, R, T; 5760–6150′; **J, G, P, U;** ds, fr, pg, pj, ra.
Sarcobatus vermiculatus (Hook.) Torr. **[2,-,-,-]** D, R; 6000–7000′; **J;** ds, fr.
Suckleya suckleyana (Torr.) Rydb. **[1,-,-,6]** D, R, T; 7050–9020′; **J, P, U;** ml.

Cleomaceae [Capparaceae]

Cleome serrulata Pursh **[3,-,7,-]** D, L, R; 5300–8370′; **J, G;** mm, ra.
Polanisia dodecandra (L.) DC. var. *trachysperma* (Torr. & A. Gray) H.H. Iltis **[3,-,7,-]** D, L; 5300–6140′; **J, G;** fr, pj, ra.
Wislizenia refracta Engelm. var. *refracta* [**UNM-***Talley 25*] D; **J.**

Commelinaceae

Commelina dianthifolia Delile **[-,5,3,2]** D, R; 6200–9200′; **J, U;** br, mm, pj, pp, ra.
Tradescantia occidentalis (Britton) Smyth var. *occidentalis* **[3,-,-,7]** R, T; 5800–7280′; **J, P, U;** ds, fr, pg, pj.
Tradescantia occidentalis (Britton) Smyth var. *scopulorum* (Rose) Anderson & Woodson **[-,-,-,1]** R; 6500′; **U;** pj.

Convallariaceae [traditionally in Liliaceae]

Maianthemum racemosum (L.) Link var. *amplexicaule* (Nutt.) Dorn **[25,5,2,4]** D, R; 6800–10900′; **J, U;** af, br, mc, mm, mr, ms, pp, sf.
Maianthemum stellatum (L.) Link **[25,3,1,5]** D, R; 6880–10150′; **J, U;** af, mc, mm, mr, ms, pp, sf.

Convolvulaceae

Calystegia sepium (L.) R. Br. var. *angulata* (Brummitt) N.H. Holmgren **[-,-,2,-]** L; 5400–5500′; **J;** mr.
*•*Convolvulus arvensis* L. **[20,-,-,4]** D, L, R, T; 5550–8360′; **J, G, P, U;** fr, mm, mr, pg, pj, pp, ra.
Cuscuta aplanata Engelm. **[-,-,3,-]** D, L; 5400–6500′; **J;** ra.
Cuscuta umbellata Kunth **[-,-,-,5]** R, T; 6750–7185′; **P, U;** ds, fr, pj.
Evolvulus nuttallianus Roemer & Schult. **[2,-,1,3]** D, R, T; 5960–6720′; **J, P, U;** fr, pg, pj.
Ipomoea cristulata H. Hall **[-,-,2,1]** D, R; 6000–8350′; **J, U;** fr, pp.
* *Ipomoea purpurea* (L.) Roth [**UNM-***Dixon A-348*] D; **U.**

Cornaceae

◆ *Cornus canadensis* L. **[4,-,-,-]** D; 8300–8475′; **J;** mm, mr.
Cornus sericea L. var. *sericea* **[24,4,1,2]** D, L, R; 6800–8850′; **J, U;** br, mc, mm, mr, ms.

Crassulaceae

Sedum cockerellii Britton **[-,2,1,-]** D, L; 7200–9050′; **J;** ms, pj, pp.
Sedum lanceolatum Torr. ssp. *lanceolatum* **[-,-,-,1]** R; 8600′; **U;** mr.
Sedum rhodanthum A. Gray **[-,-,-,2]** R; 9980–11000′; **U;** mr.

Cucurbitaceae

Cucurbita foetidissima Kunth **[2,-,1,-]** D, R; 5710–6500′; **J;** fr, ml, ra.

Cyperaceae

Carex aquatilis Wahlenb. var. *aquatilis* **[6,6,-,9]** D, R; 8350–11000′; **J, U;** mc, mm, mr.
Carex atherodes Spreng. **[1,-,-,-]** R; 10300′; **J;** ml.
Carex athrostachya Olney **[-,-,-,2]** R; 8350–9200′; **U;** mr.
Carex aurea Nutt. **[2,2,-,1]** D, R; 8000–10230′; **J, U;** mc, mm, mr.
Carex bebbii (L.H. Bailey) Olney ex Fernald [**UNM-***Worthington 32790*] R; **U.**
Carex bella L.H. Bailey **[1,6,-,1]** D, R; 8900–11150′; **J, U;** mm, mr, sf.
Carex bolanderi Olney **[-,-,1,-]** D; 6800′; **J;** mr.
Carex brevior (Dewey) Mack. ex. Lunell **[-,-,1,-]** D; 5600′; **J;** fr.
Carex brunnescens (Pers.) Poir. var. *brunnescens* **[-,1+C,-,-]** D; 8660′; **J;** ml.
Carex canescens L. var. *canescens* **[4,5,-,4]** D, L, R; 7500–10900′; **J, U;** mc, mm, mr.
Carex conoidea Willd. **[-,C,-,-]** D; 8750′; **J;** mm.
! *Carex deweyana* Schwein. var. *deweyana* **[1,C,-,1]** L, R; 7000–8500′; **J, U;** mc, mr.
Carex disperma Dewey **[3,2,-,-]** D, L, R; 7740–10000′; **J;** mr.
Carex douglasii Boott **[1,8,2,5]** D, L, R; 7050–9250′; **J, U;** mm, mr, pp, ra.
Carex duriuscula C.A. Mey. **[1,1,-,7]** D, R, T; 6850–10330′; **J, P, U;** ds, mc, mm, mr, pj.
Carex ebenea Rydb. **[-,-,-,1]** R; 10230′; **U;** mm.
Carex echinata Murray var. *echinata* **[-,C,-,1]** D, R; 9300–10020′; **J, U;** mr.
Carex emoryi Dewey **[2,-,-,-]** D, L; 5600–7675′; **J, G;** fr, ml.
Carex filifolia Nutt. var. *filifolia* **[1,-,-,4]** D, R; 6300–8500′; **J, U;** mm, ms, pj, pp.
Carex geophila Mack. **[3,10,1,24]** D, R, T; 6850–11000′; **J, P, U;** mc, mm, mr, ms, pj, pp, ra, sf.
Carex geyeri Boott **[1,-,-,4]** D, R; 8460–10900′; **J, U;** mc, mm.

Carex hystericina Muhl. ex Willd. **[1,-,2,-]** D, L, R; 5400–7000'; **J;** fr, mr.

Carex illota L.H. Bailey **[-,-,-,1]** R; 10700–11000'; **U;** mr.

Carex inops L.H. Bailey subsp. *heliophila* (Mack.) Crins **[5,4,-,16]** D, R, T; 7130–9450'; **J, P, U;** br, mc, mm, mr, pj, pp.

Carex interior L.H. Bailey **[1,-,-,-]** D; 8000–8100'; **J;** mm.

Carex jonesii L.H. Bailey **[-,-,-,1]** R; 9500–9800'; **U;** mr.

Carex macloviana d'Urv. **[-,-,-,4]** R; 9000–9800'; **U;** mr.

Carex microptera Mack. **[25,41,2,14]** D, L, R; 6600–11150'; **J, U;** af, br, mc, mm, mr, ms, sf.

Carex nebrascensis Dewey **[3,-,-,3]** D, R; 7330–10150'; **J, G, U;** mm, mr.

Carex obtusata Lilj. [**UNM**-*Chauvin 03BD032-G5*] D; **J.**

Carex occidentalis L.H. Bailey **[39,41,3,12]** D, L, R; 5860–10900'; **J, G, U;** br, mc, mm, mr, ms, pj, pp, ra, sf.

Carex pellita Muhl. ex Willd. **[8,4,3,5]** D, L, R; 7000–9800'; **J, U;** ml, mm, mr, ra.

Carex petasata Dewey **[-,1,-,-]** D; 8810–8925'; **J;** mm.

Carex pityophila Mack. **[2,6,-,5]** D, R; 7100–11000'; **J, U;** af, mc, mm, mr, pp, sf.
[*Carex geophila* Mack.]

Carex praegracilis Boott **[1,-,1,4]** D, R; 8000–10600'; **J, U;** mc, mm, mr.

Carex praticola Rydb. **[-,-,-,1]** R; 10175–10600'; **U;** mm.

! *Carex rosea* Schkuhr ex Willd. **[2,-,-,-]** D; 7025–7750'; **J;** mm, pp.

Carex rossii Boott **[5,8,-,1]** D, R; 8300–10675'; **J, U;** mc, mm, mr, pp, sf.

Carex scoparia Schkuhr ex Willd. var. *scoparia* **[1,-,-,-]** D; 7780–7940'; **J;** mr.

Carex siccata Dewey **[3,10,-,11]** D, R; 8075–11150'; **J, U;** mc, mm, mr, ra, sf.
[*Carex foenea* Willd. var. *foenea*]

Carex simulata Mack. **[1,7,-,-]** D, R; 8350–9180'; **J, U;** mc, ml, mm, mr.

Carex sprengelii Dewey ex Spreng. **[2,-,-,-]** D; 7275–8475'; **J;** mr.

Carex stevenii (Holm) Kalela **[1,1,-,-]** D, R; 8700–9625'; **J;** mr.

Carex stipata Muhl. ex Willd. var. *stipata* **[10,7,3,-]** D, R; 6600–9150'; **J, U;** af, mc, ml, mm, mr.

Carex subfusca Boott **[4,-,-,2]** D, L, R; 6850–10230'; **J, U;** mc, mm, mr.

! *Carex tahoensis* Smiley [**UNM**-*Gierisch 3146*] R; **U.**

Carex utriculata Boott **[7,13,-,8]** D, L, R; 7920–10900'; **J, U;** mc, mm, mr.

Carex vallicola Dewey **[-,-,-,5]** R, T; 7200–10900'; **P, U;** ds, mm, mr, pp.

Carex vulpinoidea Michx. **[2,-,-,-]** D, L; 5550–7490'; **J, G;** mm, mr.

Carex wootonii Mack. **[1,5,-,-]** D; 8380–9300'; **J;** mc, mm, mr.

Cyperus bipartitus Torr. **[-,-,1,-]** D; 5360'; **J;** fr.
[C. rivularis Kunth]

Cyperus esculentus L. var. *leptostachyus* Boeck. **[-,-,2,-]** D; 5360'; **J;** fr.

Cyperus fendlerianus Boeck. **[-,12,2,4]** D, L, R; 6650–9200'; **J, U;** mm, mr, ms, pp, ra.

Cyperus schweinitzii Torr. **[3,-,-,1]** R; 5900–6975'; **J, P, U;** fr, pg.

Cyperus squarrosus L. **[-,-,1,1]** D, R; 5360–8350'; **J, U;** fr, pp.

Eleocharis acicularis (L.) Roem. & Schult. **[1,1,-,3]** D, R; 8460–9150'; **J, U;** ml, mm, mr.

Eleocharis palustris (L.) Roem. & Schult. **[5,13,1,10]** D, L, R; 5600–10900'; **J, G, U;** fr, mc, ml, mm, mr, pp, ra.

Eleochris parishii Britton [**UNM**-*Worthington 32762*] R; **U.**

Eleocharis quinqueflora (F.X. Hartmann) O. Schwarz **[-,1,-,1]** D, R; 8600–9300'; **J, U;** mr.

Eleocharis rostellata (Torr.) Torr. **[-,-,-,2]** R; 6500–7100'; **U;** fr, ml.

Schoenoplectus acutus (Muhl. ex Bigelow) Å. Löve & D. Löve var. *occidentalis* (S. Watson) S.G. Sm. **[1,-,-,-]** R; 6010–7000'; **J;** ml.

Schoenoplectus americanus (Pers.) Volkart ex Schinz & R. Keller **[-,-,-,2]** R; 6500–7100'; **U;** fr, ml.

Schoenoplectus pungens (Vahl) Palla var. *longispicatus* (Britton) S.G. Sm. **[5,-,-,-]** D, L, R; 5600–7200'; **J, G;** fr, ml, mr.
[*Schoenoplectus pungens* var. *pungens*]

Schoenoplectus tabernaemontani (C.C. Gmelin) Palla **[-,-,-,1]** R; 6550–7100'; **U;** fr.

Scirpus microcarpus J. Presl & C. Presl **[8,2,1,3]** D, R; 7080–10020'; **J, U;** mm, mr.

Scirpus pallidus (Britton) Fernald **[3,-,-,-]** D; 6400–7330'; **J;** mm, mr.

Elaeagnaceae

*•*Elaeagnus angustifolia* L. **[9,-,1,4]** D, L, R, S; 5470–7300'; **J, G, U;** fr, ml, mr, ra.

Shepherdia argentea (Pursh) Nutt. **[2,-,-,-]** R; 6000–7480'; **J;** fr, ra.

Shepherdia canadensis (L.) Nutt. **[6,1,-,1]** D, L, R; 8340–9180'; **J, U;** mc, mm, mr, pp.

Elatinaceae

Elatine rubella Rydb. **[-,-,1,-]** D; 8900'; **J;** mr.

Ericaceae

Arctostaphylos uva-ursi (L.) Spreng. **[17,17,2,8]** D, L, R; 7350–10225'; **J, U;** af, mc, mm, mr, ms, pp, ra, sf.

Chimaphila umbellata (L.) W.P.C. Barton var. *occidentalis* (Rydb.) S.F. Blake **[3,-,-,-]** L; 7000–8000'; **J;** mc, mr.
[*Chimaphila umbellata* var. *acuta* (Rydb.) S.F. Blake]

Moneses uniflora (L.) A. Gray **[1,2,-,-]** D, R; 9050–10000'; **J;** mc, mr, sf.

Monotropa hypopithys L. **[-,6,3,-]** D, R; 6350–10230'; **J;** af, mc, mm, mr.

Orthilia secunda (L.) House **[4,6,1,-]** D, R; 6950–10600'; **J;** af, mc, mm, mr, sf.

Pterospora andromedea Nutt. **[1,4,3,1]** D, R; 6300–9800'; **J, U;** mc, ms, pp, ra.

Pyrola asarifolia Michx. var. *asarifolia* **[-,-,1,-]** L; 7450'; **J;** mc.

Pyrola chlorantha Sw. **[2,3,4,-]** D, L, R; 7450–9650'; **J;** mc, pp, sf.

Pyrola minor L. **[2,-,-,-]** D, L; 8000–8650'; **J;** mc, mr.

Pyrola picta Sm. **[2,-,1,-]** D, L; 8020–9200'; **J;** af, mc, mr.

Vaccinium cespitosum Michx. **[1,-,-,1]** R; 9300–10135'; **J, U;** mc.

Vaccinium myrtillus L. var. *oreophilum* (Rydb.) Dorn **[8,12,1,-]** D, L, R; 8340–11150'; **J;** af, mc, mm, mr, sf.

Vaccinium scoparium Leiberg ex Coville **[3,-,-,-]** D, L, R; 9050–9625′; **J;** mc, mm, pp.

Euphorbiaceae

Chamaesyce fendleri (Torr. & A. Gray) Small var. *chaetocalyx* (Boiss.) Shinners **[14,-,2,8]** D, L, R, S, T; 5600–7660′; **J, G, P, U;** br, ds, fr, ms, pj, pp, ra.
Chamaesyce fendleri (Torr. & A. Gray) Small var. *fendleri* **[5,-,3,17]** D, L, R, T; 5300–8500′; **J, G, P, U;** fr, ms, pj, pp, ra.
Chamaesyce geyeri (Engelm.) Small **[1,-,-,-]** L; 5500–5600′; **G;** fr.
Chamaesyce glyptosperma (Engelm.) Small **[-,-,1,6]** D, R, T; 5300–7620′; **J, P, U;** ds, fr, pj, ra.
Chamaesyce revoluta (Engelm.) Small **[-,-,1,-]** L, 6500′; **J;** pj.
Chamaesyce serpyllifolia (Pers.) Small **[4,12,5,17]** D, R, T; 5300–9200′; **J, P, U;** ds, mc, mm, mr, ms, pg, pp, ra, sf.
Chamaesyce serrula (Engelm.) Wooton & Standl. **[1,-,-,-]** D; 5710′; **J;** ra.
Croton texensis (Klotzsch) Muell. Arg. **[7,-,5,1]** L, D, R, S; 5300–6300′; **J, G, P, U;** ds, fr, pg, pj, pp, ra.
Euphorbia brachycera Engelm. **[3,2,2,-]** D, R; 6450–8250′; **J;** mm, ms, pp, ra.
Euphorbia davidii Subils **[1,-,2,-]**D, L; 6000–7400′; **J;** ra.
Euphorbia exstipulata Engelm. **[-,-,-,1]** R; 6200′; **U;** fr.
Euphorbia spathulata Lam. **[1,-,-,-]** L; 5600–6600′; **G;** pj.
Tragia nepetifolia Cav. **[2,-,2,-]** D, L; 5600–6600′; **G;** fr, pj.

Fabaceae

Amorpha canescens Pursh **[-,-,3,-]** D, L; 6500–6600′; **J;** pj.
Amorpha fruticosa L. **[3,-,1,-]** D, L, S; 5300–5800′; **J, G;** ds, fr.
Amorpha nana Nutt. **[1,-,-,-]** L; 8000′; **J;** mr.
Astragalus agrestis Douglas ex G. Don **[-,-,-,5]** R, T; 8200–8700′; **P, U;** ds, mm, ms, pp.
Astragalus albulus Wooton & Standl. **[1,-,-,2]** R; 6010–7000′; **J, U;** fr, pj.
Astragalus allochrous A. Gray var. *playanus* (M.E. Jones) Isley **[-,-,-,3]** R, T; 6900–8600′; **P;** ds, mm, pj.
Astragalus amphioxys A. Gray var. *amphioxys* **[1,-,-,1]** D, R; 6200–6880′; **G, U;** ms, pj.
Astragalus bisulcatus (Hook.) A. Gray var. *haydenianus* (A. Gray) Barneby **[6,-,1,2]** D, R; 6900–8260′; **J, U;** ds, fr, ms, pg, pp, ra.
Astragalus ceramicus E. Sheld. var. *ceramicus* **[-,-,-,3]** R, T; 6450–7150′; **P, U;** fr, pj.
! *Astragalus cerussatus* E. Sheld. **[-,-,-,3]** R, T; 8200–8328′; **P;** ds, pg.
+♦*Astragalus cyaneus* A. Gray **[-,-,-,4]** R; 6700–7600′; **U;** pj.
Astragalus drummondii Douglas ex Hook. **[-,-,-,10]** R, T; 6850–8500′; **P, U;** ds, mm, ms, pj, pp, ra.
Astragalus flexuosus (Hook.) Douglas ex G. Don var. *flexuosus* **[1,-,-,4]** R, T; 7050–9450′; **J, P, U;** mm, pj, pp, ra.
Astragalus flexuosus (Hook.) Douglas ex G. Don var. *greenei* (A. Gray) Barneby **[1,-,2,1]** D, R, S; 5700–6600′; **J, G, U;** fr, pj.
Astragalus gilensis Greene **[2,3,-,-]** D; 8025–8375′; **J;** br, mc, ms, pp.
Astragalus hallii A. Gray var. *hallii* **[-,-,-,1]** R; 8250′; **U;** mm.
Astragalus humistratus A. Gray var. *humistratus* **[3,-,-,-]** R; 7310–8120′; **J;** ds, mr, pp.
♦ *Astragalus iodopetalus* (Rydb.) Barneby **[1,-,-,-]** R; 7400–8600′; **J;** pp.
+*Astragalus kentrophyta* A. Gray var. *neomexicanus* (Barneby) Barneby **[1,-,-,-]** R; 5900–7100′; **P;** pj.
Astragalus laxmannii Jacq. var. *robustior* (Hook.) S.L. Welsh & Barneby **[1,-,-,-]** R; 5900–6000′; **G;** pj.
Astragalus lentiginosus Douglas ex Hook. var. *albiflorus* (A. Gray) Schoener **[1,-,2,3]** D, R, S, T; 5700–8350′; **G, J, P, U;** ds, fr, pj, ra.
Astragalus lonchocarpus Torr. **[10,1,1,5]** D, R; 5825–9025′; **J, U;** ds, fr, ms, pj, pp, ra.
Astragalus lotiflorus Hook. **[-,-,-,1]** R; 6400–6500′; **U;** fr.
+♦*Astragalus micromerius* Barneby **[-,-,-,1]** R; 6550–7100′; **U;** pj.
Astragalus missouriensis Nutt. var. *missouriensis* **[2,-,2,6]** D, S, R, T; 5600–8260′; **G, J, P, U;** ds, fr, pj, pp.
+ *Astragalus mollissimus* Torr. var. *matthewsii* (S. Watson) Barneby **[1,-,-,-]** D; 7640–7680′; **J;** ms.
Astragalus multiflorus (Pursh) A. Gray **[5,-,-,7]** D, R; 6900–8350′; **J, U;** ms, pj, pp, ra.
Astragalus newberryi A. Gray var. *newberryi* **[-,-,-,2]** R; 6200–7200′; **U;** pj.
Astragalus nuttallianus A. DC. var. *austrinus* (Small) Barneby **[2,-,-,-]** D; 5700–6020′; **G;** fr, pj.
Astragalus nuttallianus DC. var. *micranthiformis* Barneby **[-,-,4,1]** R; 5400–6300′; **J; U;** pj.
Astragalus pattersonii A. Gray **[1,-,-,-]** S; 5470′; **G;** fr.
Astragalus praelongus E. Sheld. var. *praelongus* **[2,-,-,2]** D, R; 5825–7250′; **J, U;** fr, ms, pj.
Astragalus proximus (Rydb.) Wooton & Standl. **[1,-,-,-]** R; 7400–8600′; **J;** pp.
+♦ *Astragalus puniceus* Osterh. var. *gertrudis* (Greene) Barneby [**UNM-**Spellenberg et al. 1231] R; **P.**
♦ *Astragalus ripleyi* Barneby **[-,-,-,2]** R; 8250–8350′; **U;** mm.
Astragalus scopulorum Porter **[2,-,-,-]** D; 5600–7150′; **J;** ds, fr.
Calliandra humilis Benth. var. *humilis* **[1,-,-,-]** D; 6950–7100′; **J;** pj, pp.
* *Colutea arborescens* L. [**UNM-***Hutchins 8472*] D; **J.**
* *Coronilla varia* L. **[-,-,1,-]** D; 6000′; **J;** ra.
Dalea candida Michx. ex Willd. var. *oligophylla* (Torr.) Shinners **[8,-,7,7]** D, L, R, T; 5300–7400′; **J, G, P, U;** fr, ms, pj, pp, ra.
Dalea cylindriceps Barneby **[-,-,3,-]** D; 5450–5700′; **J;** fr.
Dalea filiformis A. Gray **[2,-,-,-]** D; 7600–8710′; **J;** br, mc.
Dalea formosa Torr. **[4,-,3,-]** D, R, S; 5600–6400′; **J, G;** fr, ms, pj.
Dalea jamesii (Torr.) Torr. & A. Gray **[4,-,-,2]** R, S, T; 5600–6450′; **J, G, P, U;** ds, fr, pj.
Dalea lanata Spreng. var. *terminalis* (M.E. Jones) Barneby **[2,-,2,1]** D, R; 5700–6300′; **J, G, U;** ds, fr, ra.
Dalea leporina (Aiton) Bullock **[-,-,3,-]** D, L; 6000–7000′; **J;** ra.
Dalea nana Torr. & A. Gray var. *nana* **[-,-,2,-]** D; 5300–6350′; **J;** fr, ra.
Dalea polygonoides A. Gray **[-,-,1,-]** D; 6500′; **J;** pj.
Dalea purpurea Vent. var. *purpurea* **[1,-,2,-]** D; 6950–7100′; **J;** pj, pp.
* *Gleditsia triacanthos* L. **[1,-,1,-]** D, R; 5800′; **P;** fr, ra.
Glycyrrhiza lepidota Nutt. ex Pursh **[8,-,3,-]** D, L, R, S; 5300–7310′; **J, G, P;** ds, fr, mr, ms, ra.

Hedysarum boreale Nutt. var. *boreale* **[1,-,-,2]** D, R; 6100–7100'; **J, U;** fr, pj, pp.

Lathyrus eucosmus Butters & H. St. John **[4,-,-,-]** R; 6875–8100'; **J;** fr, pp, ra.

* *Lathyrus latifolius* L. **[1,-,1,-]** D; 5745–5900'; **J;** fr, ra.

Lathyrus leucanthus Rydb. **[19,14,2,17]** D, L, R; 6500–10675'; **J, U;** af, mc, mm, mr, ms, pp, sf.

* *Lotus corniculatus* L. **[1,-,-,-]** R; 7400–8600'; **J;** ra.

Lotus plebeius (Brandegee) Barneby **[4,-,-,-]** D, R; 7500–8750'; **J;** br, mm, ms, pp.

Lotus wrightii (A. Gray) Greene **[10,5,4,5]** D, L, R; 6100–8860'; **J, G, U;** br, mc, mm, ms, pj, pp, ra.

Lupinus argenteus Pursh var. *argenteus* **[-,-,2,20]** R, T; 7150–10900'; **P, U;** mc, mm, ms, pj, pp, ra.

Lupinus argenteus Pursh var. *argophyllus* (A. Gray) S. Watson **[6,6,6,25]** D, L, R, T; 6300–10150'; **J, G, P, U;** mc, mm, mr, ms, pj, pp, ra.
[*Lupinus caudatus* Kellogg var. *argophyllus* (A. Gray) S.L. Welsh]

Lupinus argenteus Pursh var. *fulvomaculatus* (Payson) Barneby **[4,1,-,5]** D, R; 7950–10200'; **J, U;** af, mc, mm, mr, ra.

Lupinus argenteus Pursh var. *parviflorus* (Nutt. ex Hook. & Arn.) C.L. Hitchc. **[2,-,-,1]** R; 9300–10135'; **J, P, U;** mc, mm.

Lupinus argenteus Pursh var. *rubricaulis* (Greene) S.L. Welsh [**RM**-*Nelson 496*] D; **J.**

Lupinus brevicaulis S. Watson **[-,-,1,1]** D, R; 6250–7237'; **P, U;** pg, pj.

Lupinus kingii S. Watson **[3,2,5,5]** D, R; 6240–9020'; **J, U;** ml, ms, pj, pp.

Lupinus polyphyllus Lindley var. *ammophilus* (Greene) Barneby **[3,-,-,-]** D, R; 7675–8000'; **J;** pj, pp, ra.
[*Lupinus ammophilus* Greene]

Lupinus polyphyllus Lindl. var. *prunophilus* (M.E. Jones) L. Phillips **[-,-,-,4]** R; 8200–9680'; **U;** mc, mr, ms.

Lupinus pusillus Pursh var. *pusillus* **[1,-,2,-]** D, L; 5300–5800'; **J, G;** fr.

Lupinus sericeus Pursh **[14,-,-,3]** D, R; 7675–9100'; **J, U;** af, mc, mm, mr, ms, pp, ra.

* *Medicago lupulina* L. **[22,8,2,10]** D, R; 5300–9980'; **J, U;** af, fr, mc, mm, mr, ms, pp, ra.

* *Medicago sativa* L. **[17,2,2,4]** D, R; 5710–9640'; **J, P, U;** fr, mm, mr, pj, pp, ra.

* *Melilotus albus* Medik. **[15,7,3,4]** D, L, R; 5710–9200'; **J, G, P, U;** fr, mm, mr, pj, pp, ra.

* *Melilotus officinalis* (L.) Pall. **[40,6,2,14]** D, L, R, S, T; 5710–9625'; **J, P, U;** br, ds, fr, mc, mm, mr, ms, pj, pp, ra.

Oxytropis deflexa (Pall.) A. DC. var. *pulcherrima* S.L. Welsh & A. Huber [**UNM**-*Sivinski 1929*] R; **U.**

Oxytropis lambertii Pursh var. *bigelovii* A. Gray **[4,-,1,2]** D, L, R; 5860–9350'; **J, P, U;** ds, fr, mc, pj, ra.

Oxytropis sericea Nutt. var. *sericea* **[-,-,-,8]** R, T; 7237–10900'; **P, U;** mc, mm, pp.

Parryella filifolia Torr. & A. Gray ex A. Gray **[2,-,3,-]** L, R; 5400–5800'; **G;** fr, ra.

Pediomelum hypogaeum (Nutt. ex Torr. & A. Gray) Rydb. var. *hypogaeum* **[-,-,2,-]** D; 5460'; **J;** fr.

Phaseolus angustissimus A. Gray var. *angustissimus* **[-,-,2,-]** D, L; 5500–6500'; **J;** ra.

Phaseolus angustissimus A. Gray var. *latus* M.E. Jones **[1,-,-,-]** R; 5800'; **J;** ra.

Psoralidium lanceolatum (Pursh) Rydb. **[7,-,1,2]** D, L, R, S, T; 5300–7130'; **J, G, P, U;** ds, fr, mr, pj, ra.

Psoralidium tenuiflorum (Pursh) Rydb. **[4,-,4,-]** D, L, R; 5800–7660'; **J;** ms, pj, pp.

Robinia neomexicana A. Gray var. *neomexicana* **[41,9,4,4]** D, L, R, S; 5600–9560'; **J, G, U;** af, br, fr, mc, mm mr, ms, pp, ra.

Sophora nuttalliana B.L. Turner **[1,-,-,-]** S; 5600'; **G;** pj.

Sophora stenophylla A. Gray [**UNM**-*Spellenberg & Spellenberg 4992*] R; **G.**

* *Sphaerophysa salsula* (Pall.) DC. **[1,-,-,-]** R; 5760'; **G;** ra.

Thermopsis rhombifolia (Nutt. ex Pursh) Nutt. ex Richardson var. *divaricarpa* (A. Nelson) Isely **[7,-,-,-]** D, R; 6600–9900'; **J;** mc, mr, ms, pp, ra.

Thermopsis rhombifolia (Nutt. ex Pursh) Nutt. ex Richardson var. *montana* (Nutt.) Isely **[29,24,3,24]** D, L, R; 6600–11150'; **J, P, U;** af, br, mc, mm, mr, ms, pp, ra, sf.

Trifolium attenuatum Greene **[-,-,-,1]** R; 9300–10150'; **U;** mm.

Trifolium gymnocarpon Nutt. **[1,-,-,5]** R; 7100–8750'; **J, U;** mm, pj, pp.

* *Trifolium hybridum* L. **[-,-,1,1]** D,R; 6000–10020'; **J, U;** mr, ra.

Trifolium longipes Nutt. var. *reflexum* A. Nelson **[1,1,-,5]** D, R, S; 8200–10600'; **J, U;** mm, mr, ra.

* *Trifolium pratense* L. **[6,1,1,5]** D, R; 6500–9800'; **J, U;** fr, mm, mr, pp, ra.

* *Trifolium repens* L. **[27,37,2,7]** D, L, R; 6500–10300'; **J, U;** af, mc, ml, mm, mr, ms, pp, ra, sf.

Trifolium wormskjoldii Lehm. var. *arizonicum* (Greene) Barneby **[-,9,-,-]** D; 7950–9200'; **J;** mm, mr.

Vicia americana Muhl. ex Willd. **[42,24,7,22]** D, L, R; 6100–11000'; **J, G, U;** af, br, ds, mc, mm, mr, ms, pg, pp, ra, sf.

Vicia ludoviciana Nutt. ex Torr. & A. Gray var. *ludoviciana* **[-,-,3,-]** D; 5500–6300'; **J;** ds, pj.

Fagaceae

Quercus gambelii Nutt. **[83,30,9,48]** D, L, R, T; 5460–10900'; **J, G, P, U;** af, br, mc, mm, mr, ms, pj, pp, ra.

Quercus grisea Liebm. **[7,-,3,3]** D, L, R; 5400–8450'; **J, P, U;** mr, ms, pj, pp, ra.

Quercus turbinella Greene **[6,-,14,-]** D, L; 5400–8200'; **J, G;** br, ms, pj, pp.

× *Quercus* ×*undulata* Torr. **[4,-,12,9]** D, L, R, S; 5400–8450'; **J, P, U;** ms, pj, pp.

Fumariaceae

Corydalis aurea Willd. var. *aurea* **[14,10,-,6]** D, L, R, S, T; 6050–10900'; **J, G, P, U;** af, br, mc, mm, mr, ra, sf.

Corydalis aurea Willd. var. *occidentalis* Engelm. ex A. Gray **[6,-,2,2]** D, R; 5500–9600'; **J, U;** af, br, fr, mc, mm, mr, pj, pp, ra.

◆ *Corydalis caseana* S. Watson ssp. *brandegeei* (S. Watson) G. Ownbey **[-,-,-,1]** R; 10700–11000'; **U;** mr.

Gentianaceae

◆ *Eustoma exaltatum* (L.) Salisbury ex G. Don [**UNM**-Spellenberg & Spurrier 8249] R; **G.**

Frasera speciosa Douglas ex Griseb. **[12,5,1,1]** D, L, R; 7450–10675'; **J, U;** af, br, mc, mm, ms, pp.

Gentiana bigelovii A. Gray **[-,7,1,-]** D, L, R; 7560–10300'; **J, U;** mc, mm, mr, pp.
[*Gentiana affinis* Griseb.]

Gentiana parryi Engelm. **[-,-,-,2]** R; 10230–10600'; **U;** mm.

Gentiana prostrata Haenke ex Jacq. **[-,1,-,-]** D; 8440'; **J;** mr.

Gentianella amarella (L.) Börner var. *acuta* (Michx.) Herder **[1,5,5,1]** D, R; 8460–11275'; **J, U;** mc, mm, mr.

Gentianella amarella (L.) Börner var. *heterosepala* (Engelm.) Dorn [**UNM**-*Fleck s.n.*] R; **J.**

Gentianopsis thermalis (Kuntze) H.H. Iltis **[-,2,-,1]** D, R; 8610–10600'; **J, U;** mm, mr.

Swertia perennis L. **[-,1,-,1]** D, R; 9190–10940'; **J, U;** mm, mr.

Zeltnera arizonica (A. Gray) Mansion [**UNM**-*Tierney & Fox 563*] D; **J.**

Geraniaceae

* *Erodium cicutarium* (L.) L'Her. ex Aiton **[15,9,2,7]** D, R, S, T; 5760–9200'; **J, G, P, U;** ds, fr, mc, mm, mr, pg, pj, pp, ra.

Geranium caespitosum E. James **[29,30,5,15]** D, L, R; 5825–10200'; **J, G, U;** af, br, ds, mc, mm, mr, ms, pj, pp, ra.

Geranium richardsonii Fisch. & Trautv. **[41,44,4,15]** D, L, R; 7750–11000'; **J, U;** af, br, mc, mm, mr, ms, pp, ra, sf.

Grossulariaceae

Ribes cereum Douglas **[28,5,7,35]** D, L, R, S, T; 5600–9580'; **J, G, P, U;** ds, fr, mc, mm, mr, ms, pj, pp, ra.

Ribes inerme Rydb. var. *inerme* **[33,5,3,-]** D, L, R; 6950–9075'; **J;** af, mc, mm, mr, ms, pp, ra.

Ribes leptanthum A. Gray **[11,25,6,14]** D, R, T; 5500–10230'; **J, P, U;** af, mc, mm, mr, ms, pj, pp, ra, sf.

Ribes montigenum McClat. **[3,3,-,2]** D, L, R; 7550–11150'; **J, U;** mc, mm, mr, sf.

Ribes wolfii Rothrock **[6,10,2,-]** D, L, R; 8200–10700'; **J;** af, mc, mm, mr, sf.

Haloragaceae

Myriophyllum sibiricum Komarov **[-,-,-,1]** R; 8200–8350'; **U;** mr.

Hydrangeaceae

Fendlera rupicola A. Gray var. *falcata* (Thornber) Rehder **[1,-,-,-]** D; 6010–6460'; **J;** fr.

Fendlera rupicola A. Gray var. *wrightii* A. Gray **[2,-,1,-]** L, R; 5500–7950'; **J;** fr, mm.

Jamesia americana Torr. & A. Gray var. *americana* **[25,23,3,2]** D, L, R; 6300–10300'; **J, U;** af, br, mc, mm, mr, ms, sf.

Philadelphus microphyllus A. Gray **[9,6,7,-]** D, L, S; 5860–9200'; **G, J;** br, mc, mr, ms, pj, pp, ra.
[*Philadelphus microphyllus* subspecies]

Hydrocharitaceae

Elodea bifoliata H. St. John **[-,2,-,-]** D; 8560–9570'; **J;** ml, mr.

Elodea canadensis Michx. **[2,3,-,2]** D, R; 7960–10020'; **J, U;** ml, mr.

Hydrophyllaceae

Hydrophyllum fendleri (A. Gray) A. Heller var. *fendleri* **[12,7,3,3]** D, L, R; 6500–10900'; **J, U;** af, mc, mm, mr, sf.

Nama dichotomum (Ruiz & Pavon) Choisy **[-,-,2,3]** D, R, T; 6990–8328'; **J, P, U;** br, pg, pj.

Nama hispidum A. Gray **[-,-,1,1]** D, R; 5530–6200'; **J, U;** ds, fr.

Nama retrorsum J.T. Howell **[3,-,-,-]** R; 5760–6090'; **J, G;** ds, fr, ra.

Phacelia alba Rydb. **[5,1,-,6]** D, R, T; 7185–9850'; **J, P, U;** mc, mm, mr, ms, pg, pp.

Phacelia caerulea Greene **[1,-,2,-]** D, L; 5500–5600'; **J, G;** fr, pj.

Phacelia crenulata Torr. ex. S. Watson **[-,-,3,3]** D, R, S, T; 6200–6760'; **J, P, U;** ds, pj.

Phacelia heterophylla Pursh var. *heterophylla* **[15,15,1,10]** D, L, R; 7200–10940'; **J, U;** br, mc, mm, ms, ra, sf.

Phacelia integrifolia Torr. var. *integrifolia* **[5,-,2,11]** D, L, R, S, T; 5470–6980'; **J, G, P, U;** ds, fr, pj, ra.

Phacelia pinkavae N.D. Atwood **[-,-,5,-]** D, S; 5500–6600'; **J;** pj.

Hypericaceae

Hypericum scouleri Hook. **[8,12,1,1]** D, R; 7100–9300'; **J, U;** ml, mm, mr, ms.

Iridaceae

Iris missouriensis Nutt. **[41,40,3,25]** D, L, R; 7100–11150'; **J, U;** af, br, mc, ml, mm, mr, ms, pp, ra, sf.

Sisyrinchium demissum Greene **[2,-,1,-]** D, R; 5300–7490'; **J, U;** mm, mr.

Sisyrinchium idahoense E.P. Bicknell var. *occidentale* (E.P. Bicknell) D.M. Hend. **[2,-,-,-]** R; 7060–7200'; **J;** fr, mr.

Sisyrinchium montanum Greene var. *montanum* **[1,5,1,3]** D, R; 8400–10900'; **J, U;** ml, mm, mr.

Juglandaceae

! *Juglans nigra* L. **[-,-,3,-]** D; 6000'; **J;** mr.

Juncaceae

Juncus arcticus Willd. var. *balticus* (Willd.) Trautv. **[25,27,2,24]** D, R; 5825–9830'; **J, U;** fr, mc, ml, mm, mr, ms, pp ra.

Juncus arcticus Willd. var. *mexicanus* (Willd. ex Roem. & Schult.) Balslev **[5,-,-,-]** D, R; 6500–8700'; **J;** mc, mm, mr, ra.

Juncus bufonius L. **[1,1,1,-]** D, R; 5360–8920'; **J, U;** mc, mr.

Juncus confusus Cov. **[-,-,1,4]** L, R; 6550–10600'; **J, U;** fr, mr, mm.

Juncus drummondii E. Mey. **[-,-,-,1]** R; 10350–10940'; **U;** mm.

Juncus dudleyi Wiegand **[8,5,1,1]** D, L, R; 5600–10100'; **J, G, U;** fr, mm, mr, ra.

Juncus ensifolius Wikstr. var. *montanus* (Engelm.) C.L. Hitchc. **[17,20,2,12]** D, L, R; 6500–10900'; **J, U;** mc, ml, mm, mr, ra, sf.

Juncus interior Wiegand **[3,10,-,1]** D, L, R; 6700–9700'; **J, U;** fr, mc, ml, mm, mr, pp, ra.

Juncus longistylis Torr. **[12,14,1,4]** D, R; 5360–10600'; **J, U;** fr, mc, ml, mm, mr, pp, ra, sf.

Juncus mertensianus Bong. **[1,-,-,-]** R; 9300–10135'; **J;** mc.

Juncus nevadensis S. Watson **[-,4,-,2]** D, R; 8500–10600'; **J, U;** ml, mm, mr.

Juncus nodosus L. **[2,-,-,1]** D, R; 6010–7100'; **J, U;** fr, pj.

Juncus tenuis Willd. **[-,1,-,-]** D; 7920–7990'; **J;** mr.

Juncus torreyi Coville **[-,1,1,-]** D; 5400–8500'; **J;** mr.

Juncus xiphioides E. Mey. **[-,-,4,-]** D, L; 5400–9700'; **J;** mr.

Luzula comosa E. Mey. **[2,2,-,-]** D, R; 9200–9720'; **J;** af, mc, mr.

Luzula parviflora (Ehrh.) Desv. **[6,6,1,3]** D, L, R; 8350–11000′; **J, U;** mc, mm, mr, sf.

Juncaginaceae

Triglochin maritima L. **[2,-,-,-]** D; 6330′; **J;** ml.
Triglochin palustre L. **[-,2,-,-]** D; 8610–8720′; **J;** mm, mr.

Lamiaceae

+ *Agastache pallidiflora* (A. Heller) Rydb. var. *neomexicana* (Briq.) R.W. Sanders **[1,-,-,-]** D; 8000′; **J;** ms.
Dracocephalum parviflorum Nutt. **[16,24,3,9]** D, R; 5860–9700′; **J, G, U;** af, br, ds, fr, mc, mm, mr, ms, pp, ra, sf.
Hedeoma drummondii Benth. **[4,-,5,9]** D, R, S, T; 5400–7900′; **J, P, U;** ds, fr, mr, ms, pj, pp.
Hedeoma nana (Torr.) Briq. **[3,-,-,-]** D, L; 5600–6100′; **G;** fr, pj.
Hedeoma oblongifolia (A. Gray) A. Heller **[-,-,1,-]** D; 5500′; **J;** fr.
Lycopus americanus Muhl. ex W.P. Barton **[-,-,2,-]** D, L; 5400′; **J;** fr, mr.
* *Marrubium vulgare* L. **[4,1,1,5]** D, R, T; 5550–8750′; **J, P, U;** ds, ms, pj, ra.
Mentha arvensis L. **[6,11,1,7]** D, L, R; 5825–10020′; **J, U;** fr, ml, mm, mr, ra.
* *Mentha spicata* L. **[-,-,1,-]** D; 5700′; **J;** mr.
Monarda fistulosa L. var. *menthifolia* (Graham) Fernald **[15,5,9,-]** D, L, R; 5850–9580′; **J, U;** br, mc, mm, mr, ms, pp, ra.
Monarda pectinata Nutt. **[4,-,5,3]** D, L, R, S, T; 5550–7280′; **J, G, P, U;** ds, fr, pj, pp, ra.
* *Nepeta cataria* L. [**UNM**-*Robertson 1165*] D; **J.**
Poliomintha incana (Torr.) A. Gray **[1,-,-,-]** R; 5955′; **J;** fr.
Prunella vulgaris L. var. *lanceolata* (W.P.C. Barton) Fernald **[29,29,3,8]** D, L, R; 5825–10900′; **J, U;** af, fr, mc, ml, mm, mr, pp, ra, sf.
Salvia farinacea Benth. [**UNM**-*Hutchins 6648*] R; **U.**
* *Salvia pratensis* L. **[-,-,2,-]** D, L; 8200–9050′; **J;** br, ra.
Salvia reflexa Hornem. **[-,-,3,-]** D, S; 6000–6540′; **J;** br, pj, ra.
Salvia subincisa Benth. **[-,-,1,-]** S; 6500′; **J;** pj.
Satureja vulgaris (L.) Fritsch **[1,-,2,-]** D; 5900–8280′; **J;** mm, mr.
* *Scutellaria galericulata* L. **[1,1,-,-]** D; 7490–9450′; **J;** mm, mr.
Stachys pilosa Nutt. var. *pilosa* **[-,-,-,1]** R; 9000–9200′; **U;** mr.
Teucrium laciniatum Torr. **[1,-,-,-]** S; 6660–6720′; **G;** pj.

Lemnaceae

Lemna minor L. **[2,5,-,4]** D, L, R; 5600–10900′; **J, G, U;** fr, ml, mr.
Lemna valdiviana Phil. **[-,-,1,-]** D; 8000′; **J;** mr.

Lentibulariaceae

Utricularia macrorhiza LeConte **[1,-,-,-]** R; 8900′; **J;** ml.

Liliaceae (see also Alliaceae, Asparagaceae, Convallariaceae, Melanthiaceae)

Calochortus gunnisonii S. Watson var. *gunnisonii* **[2,10,2,6]** D, R; 8075–10900′; **J, U;** af, mc, mm, ms, pp.
Calochortus nuttallii Torr. & A. Gray **[2,-,1,6]** D, R, T; 6200–8600′; **J, P, U;** ds, ms, pj, pp.
Erythronium grandiflorum Pursh var. *grandiflorum* [**UNM**-*Todsen 95-7-13A*] R; **U.**
♦ *Lilium philadelphicum* L. [-,-,1,-] D; 6800′; J; mr, mc.
Prosartes trachycarpum S. Watson **[2,-,-,-]** D; 8500–9050′; **J;** mc.
Streptopus amplexifolius (L.) DC. **[7,3,-,-]** D, L, R; 8350–9920′; **J;** af, mc, mr, sf.

Linaceae

Linum aristatum Engelm. **[2,-,-,-]** R; 5800–6300′; **P;** fr, ra.
Linum australe A. Heller var. *australe* **[4,-,-,2]** R, T; 7200–8600′; **J, P, U;** mm, pj, pp, ra.
Linum compactum A. Nelson **[-,-,2,-]** D; 6000′; **J;** pj, ra.
Linum lewisii Pursh var. *lewisii* **[7,3,1,2]** D, R, S; 6660–11150′; **J, G, U;** ds, mc, mm, mr, pj, pp, ra, sf.
Linum neomexicanum Greene **[-,-3,-]** D, L; 7150–8200′; **J;** br, pp.
Linum pratense (Norton) Small **[-,-,-,1]** R; 6700–6980′; **U;** pj.
Linum puberulum (Engelm.) A. Heller **[-,-,1,4]** D, R, T; 6300–7000′; **J, P, U;** ds, pj.

Loasaceae

Mentzelia albicaulis (Douglas ex Hook.) Douglas ex Torr. & A. Gray **[2,-,3,3]** D, L, R, S, T; 5400–7150′; **J, G, P, U;** fr, pj.
+♦*Mentzelia conspicua* Todsen **[1,-,-,-]** R; 7900–8160′; **J;** ra.
Mentzelia humilis (A. Gray) J. Darl. var. *humilis* **[-,-,-,1]** T; 8230–8320′; **P;** ds.
Mentzelia laciniata (Rydb.) J. Darl. **[2,-,-,3]** D, R, T; 6100–8560′; **J, P, U;** fr, pj, pp, ra.
Mentzelia multiflora (Nutt.) A. Gray var. *multiflora* **[15,-,1,10]** D, L, R, S, T; 5470–8475′; **J, G, P, U;** ds, fr, ms, pj, pp, ra.
Mentzelia rusbyi Wooton **[5,-,-,-]** D, R; 7675–8350′; **J;** ds, mm, ra.
+♦*Mentzelia springeri* (Standl.) Tidestr. **[1,-,5,-]** D; 5600–7250′; **J;** pj, pp, ra.

Malvaceae

* *Alcea rosea* L. **[-,-,2,-]** D, L; 6000–8900′; **J;** ra.
* *Malva neglecta* Wallr. **[3,1,1,-]** D, R; 8000–8350′; **J;** fr, mm, pp, ra.
Sidalcea candida A. Gray var. *candida* **[16,14,5,8]** D, L, R; 6200–10020′; **J, U;** mc, ml, mm, mr.
Sidalcea neomexicana A. Gray var. *neomexicana* **[1,-,-,1]** D, R; 7675–8350′; **J, U;** ml, mr.
Sphaeralcea coccinea (Nutt.) Rydb. var. *coccinea* **[14,-,3,20]** D, L, R, T; 5300–8740′; **J, G, P, U;** ds, fr, mm, pj, pp, ra.
Sphaeralcea fendleri A. Gray var. *fendleri* **[11,2,5,4]** D, R, S; 5710–8100′; **J, G, U;** ds, fr, mm, ms, pj, pp, ra.
Sphaeralcea grossulariifolia (Hook. & Arn.) Rydb. var. *pedata* (Torr. ex A. Gray) Kearney **[5,-,-,-]** D, R; 5825–8475′; **J;** fr, mm, ms, pp, ra.
Sphaeralcea incana Torr. ex A. Gray var. *cuneata* Kearney **[3,-,-,3]** D, L, R, T; 5550–7130′; **J, G, P, U;** ds, fr, pj, ra.
Sphaeralcea incana Torr. ex A. Gray var. *incana* **[1,-,-,-]** D; 7675′; **J;** ra.
Sphaeralcea parvifolia A. Nelson **[4,-,-,3]** R; 5800–6975′; **G, P, U;** fr, pg, pj, ra.

Melanthiaceae [traditionally in Liliaceae]

Veratrum californicum T. Durand var. *californicum* **[2,8,-,7]** D, L, R; 8625–10900′; **J, U;** mc, ml, mm, mr.
Zigadenus elegans Pursh **[2,10,3,3]** D, L, R; 7500–11150′; **J, U;** mc, mm, mr, sf.
[*Anticlea elegans* (Pursh) Rydb.]

Moraceae

* *Morus alba* L. **[2,-,1,-]** D, L; 5400–5800′; **J, G;** fr.

Nyctaginaceae

+ ◆*Abronia bigelovii* Heimerl **[-,-,-,2]** R; 6550–7100′; **U;** pj.

Abronia fragrans Nutt. ex Hook. **[6,-,-,6]** D, R, S, T; 5470–7220′; **J, G, P, U;** ds, fr, pj.

Boerhavia spicata Choisy [**UNM-***Yarnell 189*] D; **J.**

Mirabilis albida (Walter) Heimerl **[-,20,-,-]** D; 7950–9580′; **J;** mc, mm, mr, ms, pp, ra.

Mirabilis glabra (S. Watson) Standl. **[2,-,-,3]** R, T; 6000–6975′; **J, P, U**; fr, pj, ra.

Mirabilis linearis (Pursh) Heimerl var. *decipiens* (Standl.) S.L. Welsh **[2,-,3,8]** D, R; 8300–8475′; **J, U;** mm, mr.

Mirabilis linearis (Pursh) Heimerl var. *linearis* **[9,2,1,10]** D, L, R; 5950–8900′; **J, G, P, U;** br, ds, mm, mr, pj, pp, ra.

Mirabilis melanotricha (Standl.) Spellenb. **[2,-,-,-]** D; 8000–8700′; **J;** mm, pp.

Mirabilis multiflora (Torr.) A. Gray var. *glandulosa* (Standl.) J.F. Macbr. **[-,-,7,-]** D, L; 6000–6500′; **J;** pj.

Mirabilis multiflora (Torr.) A. Gray var. *multiflora* **[8,-,-,10]** D, L, R, S, T; 5600–8100′; **J, G, P, U;** br, ds, fr, pj, pp.

Mirabilis oxybaphoides (A. Gray) A. Gray **[-,-,2,3]** D, R, T; 6100–8328′; **J, P, U;** mr, pg, pj.

Oleaceae

Forestiera pubescens Nutt. **[12,1,8,3]** D, L, R, S; 5470–8940′; **J, G, U;** fr, mc, mr, pj, ra.

Fraxinus pennsylvanica* Marshall **[-,-,1,-] D; 5400′; **J;** fr.

Menodora scabra A. Gray **[-,-,1,-]** D; 5700′; **J;** fr.

Onagraceae

Chamerion angustifolium (L.) Holub var. *canescens* (Wood) N. Holmgren & P. Holmgren **[8,5,1,3]** D, R; 7330–11000′; **J, P, U;** mc, mm, mr, ra.
[*Chamerion angustifolium* subsp. *circumvagum* Mosquin]

Circaea alpina L. var. *alpina* **[1,-,2,-]** L; 8000′; **J;** mr.

Epilobium anagallidifolium Lam. **[1,-,-,1]** R; 9300–10900′; **J, U;** mc, mr.
[*Epilobium alpinum* L.]

Epilobium brachycarpum C. Presl **[-,2,1,5]** D, R; 7200–10180′; **J, U;** br, mm, mr, ra.

! *Epilobium campestre* (Jeps.) Hoch & W.L. Wagner **[-,-,-,1]** R; 8720–8740′; **U;** ml.
[*Epilobium pygmaeum* (Speg.) Hoch & P.H. Raven]

Epilobium ciliatum Raf. var. *ciliatum* **[11,19,3,8]** D, R; 5400–10900′; **J, U;** fr, ml, mm, mr, ra.
[*Epilobium ciliatum*]

! *Epilobium ciliatum* Raf. var. *glandulosum* (Lehm.) Dorn **[-,3,-,1]** D, R; 8900–9800′; **J, U;** mm, mr, ra.
[*Epilobium ciliatum*]

Epilobium halleanum Haussk. **[1,4,-,1]** D, R; 8600–11000′; **J, U;** mm, mr, ra.

Epilobium hornemanii Rchb. var. *hornemanii* [**UNM-***Fleck s.n.*] R; **U.**

Epilobium saximontanum Haussk. **[-,3,-,2]** D, R; 8650–10150′; **J, U;** mm, mr.

Gayophytum diffusum Torr. & A. Gray var. *strictipes* (Hook.) Dorn **[-,2,-,9]** D, R; 7900–9500′; **J, U;** mc, mm, ms, pj, pp.

Gayophytum ramosissimum Torr. & A. Gray **[-,-,-,7]** R, T; 7150–9250′; **P, U;** mm, pj, pp.

Oenothera albicaulis Pursh **[2,-,4,6]** D, R, S, T; 5500–7900′; **J, G, P, U;** ds, fr, pj, pp.

* *Oenothera biennis* L. **[-,-,-,1]** R; 8350′; **U;** ra.

Oenothera brachycarpa A. Gray **[-,-,1,-]** D; 6400′; **J;** pj.

Oenothera cespitosa Nutt. var. *macroglottis* (Rydb.) Cronquist **[4,-,-,9]** D, L, R, T; 6100–8475′; **J, G, P, U;** ds, ms, pj, pp, ra.

Oenothera cespitosa Nutt. var. *marginata* (Nutt. ex Hook. & Arn.) Munz **[10,-,1,3]** D, L, R, S, T; 5440–8375′; **J, G, P, U;** fr, ms, pj, pp.

Oenothera cespitosa Nutt. var. *navajoensis* (W.L. Wagner, Stockh., & W.M. Klein) Cronquist **[1,-,-,1]** D, R; 6200–7700′; **J, U;** pj, pp.

Oenothera coronopifolia Torr. & A. Gray **[11,3,1,18]** D, R, T; 6000–9000′; **J, P, U;** ds, mm, ms, pj, pp, ra.

Oenothera curtiflora W.L. Wagner & Hoch **[4,-,1,-]** D, L, R; 5710–6330′; **J, G, P;** fr, pj, ra.

Oenothera elata Kunth var. *hirsutissima* (A. Gray ex S. Watson) Cronquist **[14,-,6,-]** D, L, R, S; 5850–8500′; **J, U;** br, mc, mm, mr, pp, ra.

Oenothera flava (A. Nelson) Garrett **[3,16,1,3]** D, R; 7550–9600′; **J, U;** mc, ml, mm, mr, pp, ra.

Oenothera hartwegii Benth. ssp. *fendleri* (A. Gray) W.L. Wagner & Hoch **[-,-,4,-]** D; 5600–6500′; **J;** fr, pj.

Oenothera pallida Lindley var. *latifolia* Rydb. **[-,-,4,-]** D; 5450–6250′; **J;** fr.

Oenothera pallida Lindl. var. *pallida* **[1,-,-,-]** R; 6000–6300′; **J;** fr.

Oenothera pallida Lindl. var. *runcinata* (Engelm.) Cronquist **[7,-,-,6]** D, L, R, S, T; 5600–7500′; **J, G, P, U;** ds, fr, ms, pj, pp.

Oenothera serrulata Nutt. **[1,-,-,-]** R; 5850–5900′; **J;** pg.

Oenothera suffrutescens (Seringe) W.L. Wagner & Hoch **[21,-,4,-]** D, L, R, S; 5550–8475′; **J, G, U;** ds, fr, pg, pj, pp, ra.

Oenothera villosa Thunb. var. *strigosa* (Rydb.) Dorn **[1,4,-,-]** D; 7950–8400′; **J;** mm, mr, ms, pp.

Orchidaceae

Calypso bulbosa (L.) Oakes var. *americana* (R. Br.) Luer **[4,-,1,-]** D, R; 7500–9300′; **J;** mc.

Corallorrhiza maculata (Raf.) Raf. var. *maculata* **[-,-,1,-]** D; 6600′; **J;** mr.

Corallorrhiza maculata (Raf.) Raf. var. *occidentalis* (Lindl.) Ames **[8,9,3,3]** D, L, R; 6600–10900′; **J, U;** af, mc, mm, mr, sf.

Corallorhiza striata Lindl. var. *vreelandii* (Rydb.) L.O. Williams **[-,-,3,-]** D, L, R; 8200–8900′; **J;** pp, mc.

Corallorrhiza wisteriana Conrad **[1,2,-,-]** D, R; 9100–10050′; **J;** mc, mm, mr.

◆ *Cypripedium parviflorum* Salisb. var. *pubescens* O.W. Knight **[-,-,2,-]** L; 7200–7700′; **J;** ms.

◆ *Epipactis gigantea* Douglas ex Hook. **[1,-,1,1]** D, L, R; 5940–7250′; **G, U;** fr, ml, mr.

Goodyera oblongifolia Raf. **[2,16,1,2]** D, R; 8600–10230′; **J, U;** af, mc, mm, mr, sf.

Goodyera repens (L.) R. Br. ex W.T. Aiton **[1,3,1,-]** D, L; 7950–9000′; **J;** mc, mm, mr.

Malaxis porphyrea (Ridley) Kuntze [**UNM-***Castetter 3498*] D; **J.**

Malaxis soulei L.O. Williams **[-,5,1,-]** D; 8025–8980′; **J;** mc, mm, ms, pp.
Platanthera aquilonis Sheviak **[-,1,-,-]** D; 9050′; **J;** mr.
Platanthera huronensis (Nutt.) Lindl. **[2,1,-,4]** R; 9500–11000′; **J, U;** ml, mr.
Platanthera purpurascens (Rydb.) Sheviak & W.F. Jenn. **[2,5,-,1]** D, R; 7100–10900′; **J, U;** mc, mm, mr.
Platanthera sparsiflora (S. Watson) Schltr. **[-,-,5,-]** D; 6500–8000′; **J;** ml, mr.
♦ *Spiranthes romanzoffiana* Cham. **[-,1,-,-]** D; 8620′; **J;** ml.

Orobanchaceae (previously Scrophulariaceae)

Castilleja angustifolia (Nutt.) G. Don var. *dubia* A. Nelson **[-,-,-,2]** R; 7620–8075′; **U;** ms, pj.
Castilleja exilis A. Nelson **[2,-,1,-]** D, L, R; 5400–6560′; **G, J;** fr. [*Castilleja minor* (A. Gray) A. Gray]
Castilleja integra A. Gray **[28,1,5,39]** D, L, R, S, T; 5600–9200′; **J, G, P, U;** br, ds, fr, mm, mr, ms, pg, pj, pp, ra.
Castilleja linariifolia Benth. **[10,-,2,5]** D, R; 6150–9680′; **J, P, U;** br, ds, fr, mc, mm, pj, pp, ra.
Castilleja lineata Greene **[2,7,3,4]** D, R; 7100–10150′; **J, U;** mc, mm, mr, pp, ra.
Castilleja miniata Douglas ex Hook. var. *miniata* **[29,21,4,18]** D, L, R; 6975–10900′; **J, U;** af, br, mc, mm, mr, ms, pp, ra, sf.
Castilleja occidentalis Torr. **[-,-,-,2]** R; 9500–10940′; **U;** mr, mm.
Castilleja rhexifolia Rydb. **[1,-,-,-]** D; 10000′; **J;** mc.
Castilleja sulphurea Rydb. **[1,3,-,11]** D, R; 8350–10600′; **J, U;** mc, mm, mr, sf.
Conopholis alpina Liebm. var. *mexicana* (A. Gray ex S. Watson) Haynes **[2,-,2,-]** D; 8150–8860′; **J;** mc, ms, pj, pp, ra.
Cordylanthus wrightii A. Gray ssp. *wrightii* **[-,-,2,2]** D, L, R; 5360–7280′; **J, U;** fr, pj, ra.
Orobanche fasciculata Nutt. **[-,-,2,7]** D, R, T; 5500–8600′; **J, P, U;** ds, mm, pj.
Orobanche ludoviciana Nutt. var. *ludoviciana* **[-,-,-,1]** T; 7185′; **U;** pj.
Orobanche ludoviciana Nutt. var. *multiflora* (Nutt.) Beck **[-,-,4,3]** D, R; 5600–6975′; **J, U;** ds, fr, pj.
Orthocarpus luteus Nutt. **[1,22,1,16]** D, R, T; 7550–10230′; **J, P, U;** mc, mm, mr, ms, pj, pp, ra.
Orthocarpus purpureoalbus A. Gray ex S. Watson **[1,-,4,5]** D, L, R, T; 6500–8000′; **J, P, U;** br, ds, pj, pp.
Pedicularis centranthera A. Gray **[5,-,-,6]** D, R; 6700–8700′; **J, U;** mc, mr, ms, pj, pp, ra.
Pedicularis groenlandica Retz. **[-,-,-,4]** R; 9300–11000′; **U;** mm, mr.
Pedicularis parryi A. Gray [**UNM**-*McGrath 158*] R; **U.**
Pedicularis procera A. Gray **[7,5,1,4]** D, R; 8180–10900′; **J, U;** mc, mm, mr, sf.
Pedicularis racemosa Douglas ex Benth. var. *alba* (Pennell) Cronquist **[2,2,-,3]** D, R; 9300–11150′; **J, U;** mc, mm, mr, sf.

Oxalidaceae

Oxalis corniculata L. var. *wrightii* (A. Gray) B.L. Turner [**UNM**-*McGrath 111*] R; **U.**
Oxalis metcalfei (Small) Knuth sensu G.L. Nesom manuscript **[4,6,2,-]** D; 7950–9725′; **J;** mm, mr, pp, ra.

Parnassiaceae [previously in Saxifragaceae]

♦ *Parnassia fimbriata* Konig [**UNM**-McGrath 153] R; **U.**
Parnassia palustris L. var. *montanensis* (Fernald & Rydb. ex Rydb.) C.L. Hitchc. **[-,1,-,1]** D, R; 8610–9350′; **J, U;** mr.

Plantaginaceae [includes Callitrichaceae, Scrophulariaceae, in part]

Callitriche hermaphroditica L. **[-,1,-,1]** D, R; 8400–10020′; **J;** ml, mr.
Callitriche heterophylla Pursh var. *heterophylla* **[-,-,1,1]** D, R; 8900–10020′; **J, U;** mr.
Callitriche palustris L. **[-,15,-,2]** D, R; 8450–11000′; **J, U;** ml, mm, mr.
Collinsia parviflora Lindl. **[-,-,-,1]** R; 7800–7900′; **U;** pj.
Limosella aquatica L. **[2,2,2,2]** D, R; 5360–8980′; **J, U;** ml, mr.
*•*Linaria dalmatica* (L.) Mill. subsp. *dalmatica* **[2,-,-,-]** D; 5710–8375′; **J;** fr, ra.
*•*Linaria vulgaris* Mill. **[1,-,2,5]** D, L, R, S; 5400–9200′; **J, G, U;** br, fr, ml, mm, ra.
Lindernia dubia (L.) Pennell **[-,-,1,-]** D; 5360′; **J;** fr.
Mimulus glabratus Kunth var. *jamesii* (Torr. & A. Gray ex Benth.) A. Gray **[6,3,4,-]** D, L, R; 5500–8700′; **J, G, U;** fr, ml, mm, mr.
Mimulus guttatus DC. **[17,10,4,8]** D, L, R; 5600–11000′; **J, U;** af, mc, mm, mr, sf.
Mimulus rubellus A. Gray **[-,-,1,1]** D, R; 5460–8500′; **J, U;** fr, ms.
! *Mimulus suksdorfii* A. Gray **[-,-,-,1]** R; 7900–8075′; **U;** pj.
Mimulus tilingii Regel **[4,-,-,-]** D, R; 8000–9075′; **J;** mm, mr.
Penstemon ambiguus Torr. var. *ambiguus* **[-,-,1,-]** D, 5900′; **J;** ds.
Penstemon angustifolius Nutt. ex Pursh var. *caudatus* (A. Heller) Rydb. **[2,-,-,3]** D, R, T; 6500–7500′; **J, P, U;** ds, fr, ms, pp.
Penstemon barbatus (Cav.) Roth var. *torreyi* (Benth.) A. Gray **[39,27,4,9]** D, L, R, S, T; 5500–9850′; **J, G, P, U;** af, br, ds, fr, mc, mm, mr, ms, pj, pp, ra.
Penstemon barbatus (Cav.) Roth var. *trichander* A. Gray **[10,-,-,1]** D, R; 7300–9830′; **J, U;** af, mc, ms, pp, ra.
Penstemon crandallii A. Nelson var. *glabrescens* (Pennell) G.T. Nisbet & R.C. Jacks. **[7,-,-,17]** D, R; 7310–9200′; **J, P, U;** ds, mc, ms, pj, pp, ra.
+ *Penstemon crandallii* A. Nelson var. *taosensis* (Keck) G.T. Nisbet & R.C. Jacks. **[-,-,-,8]** D, R; 6850–9450′; **P, U;** mc, pj, pp.
! *Penstemon glaber* Pursh var. *alpinus* (Torr.) A. Gray **[1,-,-,-]** L; 7500–8900′; **J;** br.
Penstemon griffinii A. Nelson **[1,-,-,2]** R; 8000–9670′; **J, U;** ds, ms, pj.
+*Penstemon inflatus* Crosswhite **[1,1,-,-]** D; 8000–8280′; **J;** br, ms.
Penstemon jamesii Benth. **[3,-,1,-]** D, L, S; 5850–6660′; **G;** ds, fr, pj.
Penstemon linarioides A. Gray subsp. *coloradoensis* (A. Nelson) D.D. Keck **[4,-,-,-]** D, R; 7200–8000′; **J, U;** ds, mr, pj, pp.
Penstemon oliganthus Wooton & Standl. **[1,-,-,-]** D; 8240–8260′; **J;** pp.
Penstemon palmeri A. Gray **[1,-,-,-]** S; 5980–6300′; **J;** ra.
Penstemon rydbergii A. Nelson var. *rydbergii* **[-,6,1,-]** D; 7550–9075′; **J, U;** mm, mr.

Penstemon secundiflorus Benth. **[3,-,3,5]** D, L, R; 6100–8475′; **J, U;** fr, pj, ms,pj, pp.
Penstemon strictiformis Rydb. **[-,-,1,-]** S; 6200′; **J;** ra.
Penstemon strictus Benth. **[8,1,-,15]** D, R; 6775–10900′; **J, U;** af, mc, mm, ms, pp, ra.
Penstemon unilateralis Rydb. **[-,-,3,-]** D, L; 6600–6800′; **J;** pj, pp.
[*Penstemon virgatus* ssp. *asa-grayii* Crosswhite]
Penstemon virgatus A. Gray **[3,-,-,7]** D, R, T; 7025–9200′; **J, G, P, U;** ds, mm, ms, pj, pp.
Penstemon whippleanus A. Gray **[9,8,-,3]** D, L, R; 8180–11000′; **J, U;** mc, mm, mr, sf.
Plantago argyraea Morris **[6,-,-,-]** D, R; 7125–8000′; **J;** mm, pj, pp, ra.
* *Plantago lanceolata* L. **[12,1,-,1]** D, L, R; 5710–9200′; **J, G, P, U;** fr, mm, mr, ra.
* *Plantago major* L. **[13,17,2,5]** D, R; 6000–10230′; **J, U;** mc, ml, mm, mr, ra.
Plantago patagonica Jacq. **[4,-,5,9]** D, L, R, S, T; 5400–8100′; **J, G, P, U;** ds, fr, pj, pp, ra.
Synthyris plantaginea (E. James) Benth. **[5,2,2,3]** D, R; 7900–10300′; **J, P, U;** af, mc, mm, mr, pp.
Veronica americana Schwein. ex Benth. **[23,14,4,7]** D, L, R; 6000–10900′; **J, U;** af, br, mc, mm, mr.
* *Veronica anagallis-aquatica* L. **[6,-,3,1]** D, L, R, S; 5360–6500′; **J, G, U;** fr, mr.
Veronica peregrina L. var. *xalapensis* (Kunth.) St. John & F.W. Warren **[4,28,3,4]** D, L, R; 7200–10230′; **J, U;** mc, ml, mm, mr, pp, ra.
* *Veronica serpyllifolia* L. var. *humifusa* (Dickson) Vahl **[9,7,2,3]** D, L, R; 6850–10600′; **J, U;** mc, mm, mr, sf.
Veronica wormskjoldii Roem. & Schult. **[-,-,-,3]** R; 9980–11000′; **J, U;** mr.

Poaceae

Achnatherum hymenoides (Roem. & Schult.) Barkworth **[38,-,2,37]** D, R, S, T; 5300–8850′; **J, G, P, U;** br, ds, fr, mc, mm, ms, pg, pj, pp, ra.
Achnatherum lettermanii (Vasey) Barkworth **[2,28,3,14]** D, R; 8050–11000′; **J, U;** af, mc, mm, mr, ms, pp, ra, sf.
Achnatherum lobatum (Swallen) Barkworth **[-,-,-,3]** R; 6300–7600′; **U;** ds, pj.
! *Achnatherum nelsonii* (Scribn.) Barkworth var. *nelsonii* **[2,-,-,5]** D, R; 7850–10150′; **J, U;** mc, mm, ms, pp.
Achnatherum perplexum Hoge & Barkworth **[1,-,-,1]** D, R; 6975–7120′; **J, U;** pj, pp.
Achnatherum robustum (Vasey) Barkworth **[3,-,-,5]** D, R, T; 7000–8150′; **J, P, U;** ds, mm, ms, pj, pp, ra.
Achnatherum scribneri (Vasey) Barkworth [**UNM**-*Sivinski 2801*] R; **J.**
*•*Aegilops cylindrica* Host **[3,-,1,1]** D, R, S; 5440–7675′; **J, G, U;** fr, pj, ra.
* *Agropyron cristatum* (L.) Gaertn. var. *cristatum* **[6,2,3,10]** D, R, T; 6500–10000′; **J, P, U;** mc, mm, mr, ms, pp, ra.
[*Agropyron cristatum*]
* *Agropyron cristatum* (L.) Gaertn. var. *desertorum* (Fisch. ex Link) Dorn **[11,-,-,9]** D, R, T; 7100–8600′; **J, P, U;** ds, ms, pg, pj, pp, ra.
[*Agropyron cristatum*]
Agrostis exarata Trin. var. *minor* Hook. **[4,2,1,3]** D, R; 5760–10230′; **J, U;** mc, ml, mm, mr, ra.
* *Agrostis gigantea* Roth **[2,-,-,2]** D, R; 7200–9200′; **J, U;** mm, mr, ra.
Agrostis scabra Willd. **[7,43,2,11]** D, L, R; 7200–11150′; **J, U;** af, mc, mm, mr, ms, pp, ra, sf.
* *Agrostis stolonifera* L. **[10,11,5,4]** D, L, R; 5300–9950′; **J, U;** af, fr, mc, ml, mm, mr, pp, ra.
Alopecurus aequalis Sobol. var. *aequalis* **[6,23,2,12]** D, R; 7080–10900′; **J, U;** mc, ml, mm, mr, ra.
* *Alopecurus pratensis* L. **[3,-,-,2]** D, R; 7900–10900′; **J, U;** br, mr, ra.
Andropogon gerardii Vitman ssp. *gerardii* **[-,-,3,-]** D, R; 6400–7250′; **J;** pp.
Aristida adscensionis L. **[2,-,1,-]** L, R; 6090–6500′; **J, P;** pg, pj, ra.
Aristida arizonica Vasey **[-,-,2,1]** D, L, R; 6500–7300′; **J, U;** pp.
Aristida divaricata Humb. & Bonpl. ex Willd. **[-,-,1,-]** D; 6900′; **J;** pj.
Aristida purpurea Nutt. var. *fendleriana* (Steud.) Vasey **[1,-,-,13]** R, T; 6450–8300′; **J, P, U;** ds, pj, pp, ra.
Aristida purpurea Nutt. var. *longiseta* (Steud.) Vasey **[16,-,4,18]** D, L, R, S, T; 5825–9475′; **J, G, P, U;** ds, fr, ms, pg, pj, pp, ra.
Aristida purpurea Nutt. var. *nealleyi* (Vasey) Allred **[3,-,1,1]** D, L, R; 6100–7060′; **J, G, U;** fr, pj.
* *Arrhenatherum elatius* (L.) P. Beauv. ex J. Presl & C. Presl **[1,-,-,-]** R; 7890′; **J;** ra.
Beckmannia syzigachne (Steud.) Fernald **[-,1,1,2]** D, R; 5360–9200′; **J, U;** fr, ml, mr.
[*Beckmannia syzigachne* ssp. *baicaulensis* (Kusn.) T. Koyama & Kuwano]
Blepharoneuron tricholepis (Torr.) Nash **[3,49,2,10]** D, L, R; 6300–11150′; **J, G, U;** af, mc, mm, mr, ms, pp, ra, sf.
Bothriochloa barbinodis (Lag.) Herter **[-,-,1,-]** D; 5950′; **J;** pj.
Bothriochloa laguroides (DC.) Herter ssp. *torreyana* (Steud.) Allred & Gould **[2,-,-,1]** D, R; 5700–6100′; **J, G, U;** fr, pj, ra.
Bothriochloa springfieldii (Gould) Parodi **[-,-,3,-]** D; 5400–6500′; **J;** ds, pj.
Bouteloua barbata Lag. var. *barbata* **[-,-,1,1]** R, T; 6200′; **P, U;** fr.
Bouteloua curtipendula (Michx.) Torr. var. *caespitosa* Gould & Kapadia **[1,-,-,5]** R, S, T; 5760–7350′; **G, P, U;** fr, pj.
Bouteloua curtipendula (Michx.) Torr. var. *curtipendula* **[8,-,4,12]** D, L, R, S, T; 5400–7600′; **J, G, P, U;** br, fr, pg, pj, pp, ra.
Bouteloua eriopoda (Torr.) Torr. **[-,-,2,9]** D, L, R, T; 6100–7600′; **J, P, U;** ds, fr, pg, pj.
Bouteloua gracilis (Kunth) Lag. **[10,17,3,46]** D, L, R, T; 5400–9980′; **J, G, P, U;** br, ds, fr, mm, ms, pg, pj, pp, ra.
Bouteloua hirsuta Lag. **[1,-,2,1]** R; 5450–6200′; **J, P, U;** pj, ra.
Bouteloua simplex Lag. **[-,2,-,5]** D, R, T; 7185–8670′; **J, P, U;** pj, pp, ra.
Bromus carinatus Hook. & Arn. **[3,3,-,5]** D, R, S; 6140–10900′; **J, U;** br, mc, mm, mr, ra.
* *Bromus catharticus* Vahl **[3,-,1,-]** D, L, S; 5410–6330′; **J, G, U;** fr, ra.
Bromus ciliatus L. **[10,37,3,2]** D, R; 6750–11150′; **J, P, U;** af, mc, mm, mr, ms, pp, ra, sf.

Bromus frondosus (Shear) Wooton & Standl. **[,-,-,3,-]** D, L; 5600–6350′; **J;** fr, ra.

* *Bromus inermis* Leyss. **[57,12,3,26]** D, L, R, S, T; 5825–10600′; **J, P, U;** af, br, ds, fr, mc, mm, mr, ms, pp, ra.

* *Bromus japonicus* Thunb. ex Murray **[12,1,2,3]** D, L, R, S; 5500–8750′; **J, G, U;** fr, mm, mr, pg, pp, ra.

Bromus lanatipes (Shear) Rydb. **[-,-,2,3]** D, L, R; 5700–9200′; **J, U;** fr, mc, mm, mr, pj.

Bromus porteri (J.M. Coult.) Nash **[2,11,-,10]** D, L, R; 8075–10200′; **J, U;** br, mc, mm, mr, ms, pp.
[*Bromus anomalus* Rupr. ex E. Fourn.]

Bromus pumpellianus Scribn. **[1,-,-,-]** D; 9050′; **J;** mc.

Bromus richardsonii Link **[-,-,-,8]** R; 7960–11000′; **U;** af, mc, mm, mr.

* *Bromus tectorum* L. **[39,8,4,30]** D, L, R, S, T; 5550–10200′; **J, G, P, U;** af, br, ds, fr, mc, mm, mr, ms, pg, pj, pp, ra.

Calamagrostis canadensis (Michx.) P. Beauv. var. *canadensis* **[3,15,1,7]** D, L, R; 7950–11000′; **J, U;** mc, mm, mr, sf.

Calamagrostis stricta (Timm) Koeler ssp. *inexpansa* (A. Gray) C.W. Greene **[-,2,1,-]** D, R; 8620–9180′; **J, U;** ml, mr.

Cenchrus longispinus (Hack.) Fernald **[1,-,1,-]** D, R; 5400–5955′; **J;** fr.

Chloris verticillata Nutt. **[-,-,-,2]** R; 6300–6600′; **U;** ra.

* *Chloris virgata* Sw. **[2,-,-,1]** R; 5760–6600′; **G, P, U;** ra.

Cinna latifolia (Trev. ex Goepp.) Griseb. **[1,2,-,1]** D, R; 8550–9450′; **J, U;** ml, mm, mr.

***!** *Cynosurus echinatus* L. **[-,-,1,-]** D; 6100′; **J;** mr.

* *Dactylis glomerata* L. **[45,15,2,9]** D, L, R; 6000–10900′; **J, U;** af, br, mc, mm, mr, ms, pp, ra, sf.

Danthonia intermedia Vasey **[-,4,-,2]** D, R; 8690–10600′; **J, U;** mm.

Danthonia parryi Scribn. **[11,48,4,8]** D, L, R; 7550–11150′; **J, U;** af, br, mc, mm, mr, ms, pp, sf.

Danthonia spicata (L.) P. Beauv. ex Roem. & Schult. **[3,8,5,1]** D, L, R; 6200–8910′; **J, U;** mc, mm, mr, pp, ra.

Deschampsia cespitosa (L.) P. Beauv. var. *cespitosa* **[4,32,-,15]** D, R; 7550–11000′; **J, U;** mc, mm, mr, pp, sf.

Dichanthelium oligosanthes (Schult.) Gould var. *scribnerianum* (Nash) Gould **[-,-,3,-]** D; 5600–6200′; **J;** mr.

* *Digitaria sanguinalis* (L.) Scop. **[1,-,-,-]** D; 8360′; **J;** ra.

Distichlis spicata (L.) Greene var. *stricta* (Torr.) Scribn. **[1,-,1,-]** D, R; 5300–6000′; **J;** fr, ra.

* *Echinochloa crus-galli* (L.) P. Beauv. **[-,-,1,-]** D; 5460′; **J;** fr.

* *Echinochloa muricata* (P. Beauv.) Fernald var. *microstachya* Wiegand **[1,-,-,-]** R; 5760′; **G;** ra.

Elymus canadensis L. var. *canadensis* **[4,-,3,1]** D, L, R; 5400–7100′; **J, G, U;** fr, mc, mr, pp, ra.

* *Elymus elongatus* (Host) Runem. var. *elongatus* **[3,1,-,-]** D, R, S; 6150–8350′; **J, U;** mm, pp, ra.

Elymus elymoides (Raf.) Swezey var. *brevifolius* (J.G. Sm.) Dorn **[78,58,6,63]** D, L, R, S,T; 5500–11150′; **J, G, P, U;** af, ds, fr, mc, mm, mr, ms, pg, pj, pp, ra, sf.
[*Elymus longifolius* (Smith) Gould]

Elymus glaucus Buckley var. *glaucus* **[8,5,2,3]** D, L, R; 7000–10180′; **J, U;** af, br, mc, mm, mr, pp.

* *Elymus hispidus* (Opiz) Melderis var. *hispidus* **[10,9,-,3]** D, L, R; 7580–10150′; **J, U;** br, mc, mm, mr, pp, ra, sf.

* *Elymus hispidus* (Opiz) Melderis var. *ruthenicus* (Griseb.) Dorn **[7,2,2,3]** D, L, R; 6900–9980′; **J, U;** mc, mm, mr, ms, pp, ra.
[*Elymus hispidus* ssp. *barbulatus* (Schur) Melderis]

* *Elymus junceus* Fisch. **[6,-,-,4]** D, R; 6050–8900′; **J, U;** fr, mm, pj, pp, ra.
[*Psathyrostachys juncea* (Fisch.) Nevski]

Elymus lanceolatus (Scribn. & J.G. Sm.) Gould **[1,-,-,1]** L, T; 6300–8560′; **G, P;** pg, pp.

× *Elymus* ×*pseudorepens* (Scribn. & J. G. Sm.) Barkworth & Dewey **[1,-,-,-]** R; 8400–8700′; **J;** mm.

* *Elymus repens* (L.) Gould **[5,-,-,-]** D; 7100–8350′; **J;** mm, mr, ra.

× *Elymus* ×*saxicolus* Scribn. & J.G. Sm. ex Scribn. **[-,1,-,-]** D; 8000–8160′; **J;** pp.
[Unstabilized hybrid]

Elymus smithii (Rydb.) Gould **[21,7,3,27]** D, R, S, T; 5860–9500′; **J, G, P, U;** br, ds, fr, mc, mm, mr, ms, pg, pj, pp, ra.

Elymus trachycaulus (Link) Gould ex Shinners ssp. *subsecundus* (Link) Å. Löve & D. Löve **[1,6,1,1]** D, R; 8290–10180′; **J, U;** af, mc, mm, pp, ra.

Elymus trachycaulus (Link) Gould ex Shinners ssp. *trachycaulus* **[12,44,4,11]** D, L, R; 5600–10330′; **J, P, U;** af, br, ds, mc, mm, mr, ms, ra, sf.

Elymus trachycaulus (Link) Gould ex Shinners ssp. *violaceus* (Hornem.) Å. Löve & D. Löve **[-,12,-,2]** D, R; 8300–11000′; **J, U;** af, mc, mm, mr, ms, ra, sf.

* *Eragrostis cilianensis* (All.) Lutati ex Janch. **[-,-,2,-]** D; 5460–6000′; **J;** fr, ra.

* *Eragrostis curvula* (Schrad.) Nees *conferta* Stapf **[-,-,2,-]** D; 6350–6400′; **J;** ra.

Eragrostis hypnoides (Lam.) Britton, Sterns, & Poggenb. **[-,-,1,-]** D; 5360′; **J;** fr.

Eragrostis mexicana (Hornem.) Link ssp. *mexicana* **[1,-,-,-]** R; 5760′; **G;** ra.

Eragrostis pectinacea (Michx.) Nees ex Steud. var. *miserrima* (E. Fourn.) Reeder [**RM**-*Castetter 587*] D; **J.**

Eragrostis pectinacea (Michx.) Nees ex Steud. var. *pectinacea* **[1,-,2,-]** D, R; 5450–6000′; **J, G;** fr, ra.

Eragrostis trichodes (Nutt.) A.W. Wood. **[-,-,1,-]** D; 6300′; **J;** ra.

Festuca arizonica Vasey **[11,58,6,35]** L, D, R; 6000–10900′; **J, P, U;** af, br, mc, mm, mr, ms, pp, ra.

* *Festuca arundinacea* Schreb. **[18,8,1,1]** D, L, R; 5600–9250′; **J, G, U;** fr, mm, mr, pp, ra.

Festuca brachyphylla Schult. ex Schult. & Schult. f. ssp. *coloradensis* Fred. **[-,C,-,-]** D; 8550′; **J;** mm.

Festuca calligera (Piper) Rydb. **[-,-,-,6]** R; 8450–10600′; **U;** mm, pp.

Festuca idahoensis Elmer **[10,8,-,5]** D, R; 6900–9720′; **J, U;** af, mc, mm, mr, ms, pp, ra, sf.

* *Festuca pratensis* Huds. **[3,2,2,1]** D, R; 5600–8460′; **J, U;** ml, mm, mr, ra.

Festuca rubra L. ssp. *rubra* **[1,-,-,-]** R; 9475–9840′; **J;** mm.

Festuca saximontana Rydb. var. *saximontana* **[1,4,-,2]** D, R; 7940–11000′; **J, U;** mc, mm, ms, ra, sf.

Festuca sororia Piper **[-,10,2,-]** D, L, R; 8000–10150′; **J, U;** af, mc, mm, mr.

Festuca thurberi Vasey **[5,33,5,15]** D, L, R; 7950–11150′; **J, U;** af, br, mc, mm, mr, pp, ra, sf.

* *Festuca trachyphylla* (Hack.) Krajina **[-,-,1,2]** L, R; 8200–9600'; **J, U;** br, mc.
[Introduced in Jemez area after human mediated fire, etc.]

Glyceria borealis (Nash) Batch. **[1,5,3,5]** D, R; 7950–10020'; **J, U;** ml, mm, mr.

Glyceria elata (Nash ex Rydb.) M.E. Jones **[2,1,-,4]** D, R; 7100–10900'; **J, U;** ml, mm, mr.

Glyceria grandis S. Watson **[3,17,3,4]** D, L, R; 7860–10020'; **J, U;** ml, mm, mr.

Glyceria striata (Lam.) Hitchc. **[29,10,4,11]** D, L, R; 6500–10000'; **J, U;** af, br, mm, mr.

Hesperostipa comata (Trin. & Rupr.) Barkworth var. *comata* **[8,-,2,17]** D, R, S, T; 5860–10900'; **J, G, P, U;** ds, fr, mm, ms, pg, pj, pp, ra.

Hesperostipa comata (Trin. & Rupr.) Barkworth var. *intermedia* (Scribn. & Tweedy) Dorn **[8,2,-,3]** D, R; 7200–9200'; **J, U;** ds, mm, ms, pp, ra.

Hesperostipa neomexicana (Thurb. ex J.M. Coult.) Barkworth **[1,-,2,2]** D, L, R; 5600–6600'; **J, G, U;** fr, pj.

Hierochloë odorata (L.) P. Beauv. **[2,3,-,-]** D, R; 8760–9600'; **J;** mc, ml, mm.

Hilaria jamesii (Torr.) Benth. **[14,-,4,27]** D, L, R, S, T; 5530–8000'; **J, G, P, U;** ds, fr, ms, pg, pj, pp, ra.
[*Pleuraphis jamesii* Torr.]

Hopia obtusa (Kuntz) Zuloaga & Morrone **[-,-,3,-]** D; 6000'; **J;** ra.

Hordeum brachyantherum Nevski **[2,14,1,6]** D, R; 8450–10900'; **J, U;** mc, ml, mm, mr, ra.

Hordeum jubatum L. ssp. *intermedium* Bowden **[5,11,-,7]** D, R; 7500–9580'; **J, U;** mc, ml, mm, pp, ra.

Hordeum jubatum L. ssp. *jubatum* **[18,8,2,4]** D, L, R, S; 5300–9570'; **J, G, U;** br, ds, fr, mc, ml, mm, mr, ms, pj, pp, ra.

* *Hordeum murinum* L. ssp. *glaucum* (Steud.) Tzvelev **[3,-,-,1]** D, R, S; 5470–8260'; **J, G, U;** br, fr, pj, ra.

Hordeum pusillum Nutt. **[1,-,-,1]** R, S; 6300–6720'; **G, U;** pg, pj.

Koeleria macrantha (Ledeb.) Schult. **[29,58,6,43]** D, L, R, T; 5750–11150'; **J, G, P, U;** af, br, ds, fr, mc, mm, mr, ms, pj, pp, ra, sf.

Leersia oryzoides (L.) Sw. **[-,-,3,-]** D, L; 5400–5500'; **J;** fr.

* *Lolium perenne* L. var. *aristatum* Willd. **[4,-,-,-]** D, L; 7525–8250'; **J, U;** br, mm, mr, ra.

* *Lolium perenne* L. var. *perenne* **[3,-,1,1]** D, R, S; 5760–9800'; **J, G, U;** fr, mc, mm, pp, ra.

Lycurus setosus (Nutt.) C. Reeder **[-,2,2,4]** D, L, R, T; 6300–8625'; **J, P, U;** mr, pj, ra.

Melica porteri Scribn. var. *porteri* **[9,8,2,-]** D, L, R; 6975–9580'; **J;** af, mc, mm, mr, ms.

Muhlenbergia andina (Nutt.) Hitchc. **[1,-,-,-]** D; 8000–8100'; **J;** mm.

♦ *Muhlenbergia arsenei* Hitchc. **[1,-,3,-]** D, L; 5800–6600'; **J;** pj, ra.

Muhlenbergia asperifolia (Nees & Meyen ex Trin.) Parodi **[2,-,-,1]** D, R; 6550–7550'; **J, U;** fr, mr, ra.

Muhlenbergia dubia E. Fourn. ex Hemsl. **[-,-,1,-]** D; 6750'; **J;** br.

Muhlenbergia filiformis (Thurb. ex S. Watson) Rydb. **[-,-,-,6]** R, T; 8300–10200'; **P, U;** mc, mm, pj.

Muhlenbergia mexicana (L.) Trin. var. *mexicana* **[1,-,1,-]** D, R; 6300–7350'; **J, U;** mr.

Muhlenbergia minutissima (Steud.) Swallen **[1,1,1,1]** D; 6920–8300'; **J;** pj, pp, ra.

Muhlenbergia montana (Nutt.) Hitchc. **[4,46,4,17]** D, L, R, T; 6300–10300'; **J, G, P, U;** af, mc, mm, mr, ms, pj, pp, ra.

Muhlenbergia pauciflora Buckley **[-,1,2,3]** D, L, R; 6300–9050'; **J, U;** ms, pj, pp.

Muhlenbergia porteri Scribn. ex Beal **[-,-,1,-]** D; 5800'; **J;** fr.

Muhlenbergia pungens Thurb.**[3,-,-,9]** R, T; 6000–7100'; **J, P, U;** ds, fr, pg, pj, ra.

Muhlenbergia racemosa (Michx.) Britton, Sterns, & Poggenb. **[-,-,1,-]** D; 5500'; **J;** mr.

Muhlenbergia ramulosa (Kunth) Swallen **[-,7,1,1]** D, R; 8200–9980'; **J, U;** mc, mm, ms, pp, ra.

Muhlenbergia repens (J. Presl) Hitchc. **[-,1,-,-]** D; 8700'; **J;** mc.

Muhlenbergia richardsonis (Trin.) Rydb. **[-,9,-,6]** D, R, T; 7550–9800'; **J, P, U;** mc, ml, mm, mr, pp, ra.

Muhlenbergia rigens (Benth.) Hitchc. [**UNM**- *Jacobs 4276*] L; **J.**

Muhlenbergia sinuosa Swallen **[-,1,-,-]** D; 7950–8100'; **J;** pp.

Muhlenbergia thurberi Rydb. **[-,-,-,8]** R; 6200–7600'; **G, U;** fr, pj.

Muhlenbergia torreyi (Kunth) Hitchc. ex Bush **[-,-,2,11]** D, R, T; 5600–8300'; **J, P, U;** ds, pg, pj, ra.

Muhlenbergia wrightii Vasey ex J.M. Coult. **[3,14,1,9]** D, L, R, T; 6300–9220'; **J, G, P, U;** ds, mc, mm, mr, ms, pp, ra.

Munroa squarrosa (Nutt.) Torr. **[2,-,1,12]** D, L, R, T; 5400–8720'; **J, G, P, U;** ds, fr, pj, ra.

Nassella viridula (Trin.) Barkworth **[6,-,-,1]** D, R; 7100–8250'; **J, U;** ds, pg, pp, ra.

Oryzopsis asperifolia Michx. **[20,9,3,1]** D, L, R; 6600–10200'; **J, U;** af, br, mc, mm, mr, pp, sf.

Panicum bulbosum Kunth **[1,-,2,-]** D; 5850–7400'; **J;** pp.

Panicum capillare L. var. *brevifolium* (Rydb.) Shear **[-,-,1,1]** D, R; 5460–8350'; **J, U;** fr, pp.

Panicum hallii Vasey var. *hallii* **[-,-,1,-]** D; 5600'; **J;** ds.

Panicum virgatum L. **[-,-,1,-]** D; 6000'; **J;** ra.

Paspalum setaceum Michx. var. *stramineum* (Nash) Banks **[1,-,-,-]** R; 5900'; **P;** fr.

Phalaris arundinacea L. var. *arundinacea* **[2,-,2,1]** D, R; 5400–9150'; **J, U;** fr, ml, mm, mr.

Phleum alpinum L. var. *alpinum* **[-,11,2,11]** D, L, R; 5850–11150'; **J, U;** af, mc, mm, mr, ra, sf.

* *Phleum pratense* L. var. *pratense* **[19,16,2,16]** D, L, R; 5700–10180'; **J, U;** af, fr, mc, ml, mm, mr, ms, pp, ra, sf.

Phragmites australis (Cav.) Trin. ex Steud. ssp. *americanus* Saltonstall, Peterson, & Soreng **[-,-,1,-]** L; 5400'; **J;** fr.

Piptatherum micranthum (Trin. & Rupr.) Barkworth **[18,5,3,19]** D, R, S, T; 5725–8700'; **J, G, P, U;** br, ds, fr, mc, mm, mr, ms, pg, pj, pp, ra.

! *Piptatherum pungens* (Torr.) Barkworth **[-,1,-,-]** D; 8540–8740'; **J;** pp.

* *Poa annua* L. **[5,9,1,-]** D, L, R; 5550–10230'; **J;** af, mc, mm, mr, ra, sf.

Poa arctica R. Br. var. *grayana* (Vasey) Å. Löve & D. Löve & Kapoor **[-,-,-,3]** R; 8300–10150'; **U;** mc, mm.

Poa arida Vasey **[2,-,-,-]** D; 8400–9900'; **J;** af, mm.

Poa bigelovii Vasey & Scribn. [**UNM-** *Goodrow 430*] R; **U.**

* *Poa bulbosa* L. **[-,-,-,2]** R; 6950–7900'; **U;** pj.

* *Poa compressa* L. **[4,17,2,8]** D, L, R; 7800–10250'; **J, U;** af, br, mc, mm, mr, ms, pp, ra.

Poa fendleriana (Steud.) Vasey **[16,13,5,32]** D, L, R, S, T; 6000–10675'; **J, P, U;** af, ds, mc, mm, mr, pg, pj, pp, ra.
[*Poa fendleriana* subspecies]

Poa glauca Vahl var. *rupicola* (Nash ex Rydb.) B. Boivin **[-,1,-,-]** D; 10340–10875'; **J;** sf.

Poa interior Rydb. **[-,1,-,2]** D, R; 8700–10600'; **J, U;** mc, mm, sf.

Poa leptocoma Trin. **[3,-,-,1]** R; 9300–11000'; **J, U;** mc, mm, mr, sf.

Poa occidentalis Vasey **[-,6,-,2]** D, R; 8100–10900'; **J, U;** af, mc, mm, mr, pp.

Poa palustris L. **[4,6,2,5]** D, R; 7950–9950'; **J, U;** mm, mr.

* *Poa pratensis* L. **[59,39,11,40]** D, L, R, T; 5600–11150'; **J, G, P, U;** af, br, ds, fr, mc, mm, mr, ms, pg, pp, ra, sf.
[*Poa pratensis* subspecies]

Poa tracyi Vasey [**UNM-***Fleck s.n.*] R; **J.**

Poa wheeleri Vasey **[-,-,-,1]** R; 7560–7740'; **U;** mc.

* *Polypogon monspeliensis* (L.) Desf. **[-,-,2,-]** D; 5300–5400'; **J;** fr.

* *Polypogon viridis* (Gouan) Breistr. **[2,-,-,-]** L, S; 5600–5760'; **G;** fr.

Puccinellia nuttalliana (Schult.) Hitchc. [**UNM-***Sivinski 2469*] R; **J.**

Schedonnardus paniculatus (Nutt.) Trel. **[2,-,1,-]** L, R; 5650–8200'; **J;** pj, pp, ra.

Schizachne purpurascens (Torr.) Swallen **[-,1,2,-]** D, L; 7450–8950'; **J;** mm, mr

Schizachyrium neomexicanum Nash **[2,-,3,-]** D, L, R; 5760–7150'; **J, G;** pj, pp, ra.

Schizachyrium scoparium (Michx.) Nash var. *scoparium* **[10,6,-,5]** D, L, R; 5950–8450'; **J, G, P, U;** br, fr, mr, ms, pj, pp, ra.

* *Secale cereale* L. **[1,-,1,-]** L; 6650–8900'; **J;** br, pj.

Setaria grisebachii E. Fourn. **[-,-,1,-]** D; 6000'; **J;** ra.

Setaria leucopila (Scribn. & Merr.) K. Schum. **[1,-,1,-]** L; 5500–5700'; **J, G;** fr.

* *Setaria pumila* (Poir.) Roem. & Schult. **[-,-,1,-]** L; 6650'; **J;** ra.

* *Setaria viridis* (L.) P. Beauv. **[1,-,4,-]** R; 5400–6000'; **J, G;** mr, ra.

Sorghastrum nutans (L.) Nash **[1,-,2,-]** D; 6000–7350'; **J;** mr, pp.

* *Sorghum bicolor* (L.) Moench ssp. *bicolor* **[1,-,-,-]** L; 5450'; **G;** fr.

Sporobolus airoides (Torr.) Torr. **[2,-,1,4]** D, R, T; 6000–8200'; **J, P, U**; ds, fr, ms, pj, ra.

Sporobolus compositus (Poir.) Merr. var. *compositus* **[-,-,1,-]** L; 7550'; **J;** ra.

Sporobolus contractus Hitchc. **[-,-,3,7]** D, R, T; 6000–6975'; **J, P, U;** ds, fr, pj, ra.

Sporobolus cryptandrus (Torr.) A. Gray **[12,2,3,28]** D, L, R, S, T; 5500–8900'; **J, G, P, U;** br, ds, fr, mr, pg, pj, pp, ra.

Sporobolus flexuosus (Thurb. ex Vasey) Rydb. **[-,-,-,1]** R; 6200'; **U;** fr.

Torreyochloa pallida (Torr.) G.L. Church var. *pauciflora* (J. Presl) J.I. Davis **[9,12,1,-]** D, L, R; 6300–9750'; **J, U;** mc, ml, mm, mr, pp, ra.

Trisetum montanum Vasey **[4,23,2,1]** D, L, R; 7950–11150'; **J, U;** af, mc, mm, mr, ms, pp, sf.

Trisetum spicatum (L.) K. Richt. **[-,6,-,1]** D, R; 7950–10600'; **J, U;** mc, mm, mr, sf.

Trisetum wolfii Vasey **[-,1,1,2]** L, R; 8000–11000'; **J, U;** af, mm, mr, sf.

* *Triticum aestivum* L. **[3,-,-,-]** D, L, R, T; 6000–7600'; **J, P;** fr, ra.

Vulpia octoflora (Walter) Rydb. **[2,-,5,12]** D, L, R, T; 5300–8550'; **J, P, U;** ds, fr, ms, pg, pj, pp.
[*Vulpia octoflora* varieties]

Polemoniaceae

Aliciella pinnatifida (Nutt. ex A. Gray) J.M. Porter **[2,-,1,-]** L, S; 6500–8400'; **J;** mc, mr, pj.

Collomia linearis Nutt. **[1,3,-,8]** D, R; 7550–10900'; **J, U;** mc, mm, mr.

Eriastrum diffusum (A. Gray) H. Mason **[-,-,-,7]** R, T; 6050–7450'; **P, U;** ds, fr, pj.

Gilia flavocincta A. Nelson ssp. *australis* (A.D. Grant & V.E. Grant) A.D. Day & V.E. Grant **[-,-,2,-]** D; 5300–5550'; **J;** ds, fr.

Gilia ophthalmoides Brand **[-,-,1,3]** D, R; 5400–6850'; **J, U;** fr, pj.

Gilia sinuata Douglas ex Benth. **[1,-,-,1]** R, S; 6320–8075'; **G, U;** fr, pj.

Giliastrum acerosum (A. Gray) Rydb. **[1,-,-,4]** R; 5820–6600'; **G, U;** fr, pj.

Ipomopsis aggregata (Pursh) V.E. Grant ssp. *candida* (Rydb.) V.E. Grant & A.D. Grant **[-,-,-,1]** R; 8840–9200'; **U;** mm.

Ipomopsis aggregata (Pursh) V.E. Grant ssp. *collina* (Greene) Wilken & Allard **[1,-,-,-]** D; 8400–9340'; **J;** mc.

Ipomopsis aggregata (Pursh) V.E. Grant ssp. *formosissima* (Greene) Wherry **[36,28,2,28]** D, L, R, T; 6300–10940'; **J, G, P, U;** af, br, ds, mc, mm, mr, ms, pj, pp, ra.

Ipomopsis laxiflora (J.M. Coult.) V.E. Grant **[1,-,-,1]** S, T; 6320–7916'; **G, P;** ds, pj.

Ipomopsis longiflora (Torr.) V.E. Grant ssp. *longiflora* **[-,-,-,14]** R, T; 6050–7300'; **P, U;** ds, fr, pj.

Ipomopsis longiflora (Torr.) V.E. Grant ssp. *neomexicana* Wilken **[6,-,6,-]** D, L, R, S; 5300–7000'; **J, G;** ds, fr, pj, pp, ra.

Ipomopsis multiflora (Nutt.) V.E. Grant **[4,-,-,15]** D, R, T; 6300–8100'; **J, P, U;** br, ds, fr, pj, pp, ra.

Ipomopsis pumila (Nutt.) V.E. Grant [**UNM-** *Tierney P-52175-14*] D; **J.**

Leptosiphon nuttallii (A. Gray) J.M. Porter ssp. *tenuilobus* (R. Patterson) ined. **[1,-,-,-]** D; 10000'; **J;** mc.

Linanthus pungens (Torr.) J.M. Porter & L.A. Johnson **[1,-,-,4]** R, T; 7500–9250'; **J, P, U;** mm, mc, ms, pp.

Microsteris gracilis (Hook.) Greene **[1,-,-,7]** R; 7100–8500'; **J, U;** mr, pg, pj, pp.

Phlox austromontana Coville ssp. *densa* (Brand) Wherry**[1,-,-,-]** R; 6775'; **G;** pj.
[*Phlox austromontana*]

Phlox longifolia Nutt. ssp. *longifolia* **[4,-,-,3]** D, R; 7300–8350'; **J, U;** ds, pg, pj, pp, ra.

Polemonium foliosissimum A. Gray **[14,8,2,4]** D, R; 5400–10900'; **J, U;** af, mc, mm, mr, pp.

Polygalaceae

Polygala alba Nutt. var. *alba* **[1,-,-,-]** D; 7300–7600'; **J;** pp.

Polygonaceae

Bistorta bistortoides (Pursh) Small **[1,-,2,1]** D, R; 8960–10600′; **J, U;** mc, ml, mm.

Bistorta vivipara (L.) S.F. Gray [**UNM**-*Fleck s.n.*] R; **J, U.**

Eriogonum abertianum Torr. var. *abertianum* **[-,-,1,-]** D; 5500′; **J;** ds.

Eriogonum alatum Torr. var. *alatum* **[14,-,2,13]** D, L, R, T; 6450–9350′; **J, P, U;** br, ds, mc, mm, ms, pj, pp.

Eriogonum annuum Nutt. **[2,-,1,2]** D, R; 5950–7280′; **J, P, U;** fr, pj, ra.

Eriogonum arcuatum Greene var. *arcuatum* **[1,-,-,-]** D; 7000–7400′; **J;** pj.
[*Eriogonum jamesii* Benth. var. *flavescens* S. Watson]

Eriogonum cernuum Nutt. **[-,-,3,5]** D, R, T; 5300–8328′; **J, P;** ds, fr, pg, pj.

Eriogonum corymbosum Benth. var. *velutinum* Reveal **[-,-,-,1]** R; 6818–6900′; **U;** fr.

Eriogonum jamesii Benth. var. *jamesii* **[8,-,8,35]** D, L, R, T; 5300–9200′; **J, G, P, U;** ds, fr, mr, pg, pj, pp, ra.

♦+*Eriogonum lachnogynum* Torr. ex Benth. var. *colobum* Reveal & A. Clifford **[-,-,-,2]** T; 6818–6900′; **P;** ds.

Eriogonum leptophyllum (Torr. & A. Gray) Wooton & Standl. **[-,-,-,1]** R; 8250′; **U;** pj.

Eriogonum lonchophyllum Torr. & A. Gray var. *lonchophyllum* **[1,-,-,1]** D, R; 6990–7400′; **J, U;** ds, pj.

+ *Eriogonum lonchophyllum* Torr. & A. Gray var. *nudicaule* (Torr.) Reveal **[1,-,-,-]** R; 7100′; **J;** pj.

Eriogonum microthecum Nutt. var. *simpsonii* (Benth.) Reveal **[2,-,2,20]** D, L, R, T; 5400–8700′; **J, P, U;** ds, ms, pj, pg, pp.

Eriogonum polycladon Benth. **[-,-,1,-]** D; 6100′; **J;** ra.

Eriogonum racemosum Nutt. **[9,3,2,32]** D, R, T; 7000–9670′; **J, P, U;** br, mc, mm, ms, pj, pp, ra.

* *Fallopia convolvulus* L. **[1,1,1,-]** D; 6000–8750′; **J;** ds, mm, ms.

Persicaria amphibia (L.) S.F. Gray **[1,1,2,2]** D, R; 5300–9000′; **J, U;** fr, ml, mr.

* *Persicaria lapathifolia* (L.) A. Gray **[1,5,1,1]** D, R; 5360–8740′; **J, U;** fr, ml, mm, mr.

* *Persicaria maculosa* A. Gray **[6,-,4-]** D, R, S; 5300–7350′; **J, G;** fr, ml, mm, mr

* *Polygonum aviculare* L. **[4,30,4,11]** D, L, R, T; 5400–10330′; **J, P, U;** af, fr, ml, mm, mr, pp, ra.

Polygonum douglasii Greene **[1,4,1,7]** D, L, R; 7300–10230′; **J, U;** af, br, mm, mr.

Polygonum erectum L. **[1,-,-,-]** D; 7600′; **J;** ra.

Polygonum polygaloides Wallich ex Meisner ssp. *confertiflorum* (Nutt. ex Piper) Hickman **[-,-,-,2]** R; 9380–9680′; **U;** mr.

Polygonum ramosissimum Michx. var. *ramosissimum* **[2,-,-,-]** R; 5760–6090′; **G, P;** ra.

Polygonum sawatchense Small **[-,25,1,5]** D, R, T; 5900–10300′; **J, P, U;** af, fr, mc, mm, mr, ms, pj, pp, ra.

* *Rumex acetosella* L. **[14,47,3,2]** D, L, R; 6200–11300′; **J, U;** af, br, mc, mm, mr, ms, pp, ra, sf.

* *Rumex crispus* L. ssp. *crispus* **[9,12,4,-]** D, R; 5400–9700′; **J;** af, br, fr, ml, mm, mr, ra.

Rumex occidentalis S. Watson **[-,-,-,6]** R; 6500–10020′; **U;** fr, mr.

* *Rumex patientia* L. **[-,-,1,-]** D; 6950′ **J;** mr.

Rumex triangulivalvis (Danser) Rech. f. **[5,7,3,13]** D, L, R, S, T; 5400–10020′; **J, G, P, U;** fr, ml, mm, mr, ra.

Stenogonum salsuginosum Nutt. **[1,-,-,-]** D; 7000′; **J;** ds.

Portulacaceae

Lewisia pygmaea (A. Gray) B.L. Rob. **[-,-,-,2]** R; 9850–10600′; **U;** mm, sf.

Montia chamissoi (Ledeb. ex Spreng.) Greene **[2,3,-,-]** D; 8350–10000′; **J;** mm, mr.

Phemeranthus parviflorus (Nutt) Kiger **[1,-,1,2]** D, R; 6990–8650′; **J, U;** br, ms, pj, pp.

Portulaca halimoides L. **[-,-,-,1]** R; 6990′; **U;** pj.

* *Portulaca oleracea* L. **[1,-,2,17]** D, R, T; 5460–8350′; **P, U;** ds, fr, pg, pj, ml, ra.
[*Portulaca oleracea* subspecies]

Potamogetonaceae

Potamogeton alpinus Balb. **[-,2,-,1]** D, R; 8590–9950′; **J, U;** mr.

Potamogeton foliosus Raf. var. *foliosus* **[-,2,-,1]** D, R; 8500–9150′; **J, U;** mr.

Potamogeton gramineus L. **[-,2,-,-]** D, R; 7950–8625′; **J, U;** mr.

Potamogeton natans L. **[-,1,1,-]** D; 8930′; **J;** ml.

Potamogeton nodosus Poir. **[-,6,-,-]** D; 7960–9570′; **J;** ml, mr.

Potamogeton richardsonii (A. Benn.) Rydb. **[-,1,-,1]** D, R; 8500–10500′; **J, U;** mr.

Primulaceae

Androsace septentrionalis L. **[24,38,1,28]** D, L, R, T; 5860–11000′; **J, G, P, U;** af, br, fr, mc, mm, mr, ms, pj, pp, ra, sf.

Dodecatheon pulchellum (Raf.) Merr. var. *pulchellum* **[11,8,2,4]** D, R; 7550–10600′; **J, U;** mc, mm, mr.

Ranunculaceae

Aconitum columbianum Nutt. var. *columbianum* **[5,7,1,5]** D, L, R; 8000–11000′; **J, U;** af, mc, mm, mr, sf.

Actaea rubra (Aiton) Willd. **[37,9,3,3]** D, L, R; 6950–10200′; **J, U;** af, br, mc, mm, mr, ra, sf.
[*Actaea rubra* ssp. *arguta* (Nutt.) Hultén]

Anemone cylindrica A. Gray **[1,-,3,-]** D, R; 6850–8900′; **J, U;** mm, mr.

Aquilegia coerulea E. James var. *coerulea* **[4,4,2,2]** D, R, S; 8180–10900′; **J, U;** mc, mm, mr, sf.

Aquilegia elegantula Greene **[22,8,2,1]** D, L, R; 6850–10200′; **J, U;** af, br, mc, mm, mr, pp, ra, sf.

Caltha leptosepala DC. **[4,3,-,2]** D, R; 8440–11000′; **J, U;** mc, ml, mm, mr.

Clematis bigelovii Torr. **[1,-,-,-]** D; 7600′; **J;** ms.

Clematis columbiana (Nutt.) Torr. & A. Gray var. *columbiana* **[31,8,3,9]** D, L, R; 6300–10900′; **J, P, U;** af, br, mc, mr, ms, pp, ra.

Clematis hirsutissima Pursh var. *hirsutissima* **[1,-,-,]** R; 8070–8180′; **J;** ms.

Clematis hirsutissima Pursh var. *scottii* (Porter) E.O. Erickson **[-,-,-,1]** R; 7800–8500′; **U;** mr.

Clematis ligusticifolia Nutt. **[10,-,3,1]** D, R; 5300–8030′; **J, G, P;** ds, fr, mm, mr, pj, pp, ra.

Delphinium barbeyi (Huth) Huth **[3,-,-,2]** D, R; 8830–11000′; **J, U;** af, mc, mr, sf.

Delphinium nuttallianum Pritz. **[2,-,-,9]** R; 8125–10900′; **J, U;** mc, mm, ms, pj, pp.

Delphinium ramosum Rydb. **[-,-,-,1]** R; 9980–10020′; **U;** mr.

Delphinium wootonii Rydb. **[1,-,2,-]** D, S; 6320–6500′; **J, G;** ds, fr, pj.
Myosurus minimus L. **[1,-,-,-]** D; 7080′; **J;** ra.
Pulsatilla patens (L.) Mill. ssp. *multifida* (Pritz.) Zämels **[1,-,1,4]** D, L, R; 7540–9000′; **J, U;** mc, ms, pp, ra.
♦ *Ranunculus abortivus* L. **[3,-,1,-]** D, R; 6850–8550′; **J;** mm, mr.
! *Ranunculus alismifolius* Geyer ex Benth. var. *montanus* S. Watson **[3,-,-,2]** R; 9300–10600′; **J, U;** mc, mm, mr.
Ranunculus aquatilis L. var. *diffusa* With. **[2,2,2,3]** D, R; 6500–9850′; **J, U;** mr.
Ranunculus cardiophyllus Hook. **[1,12,5,-]** D, R; 7550–9150′; **J, U;** ml, mm, mr, ra.
Ranunculus cymbalaria Pursh **[9,3,2,-]** D, L, R; 5300–8580′; **J;** fr, ml, mm, mr, ra.
Ranunculus inamoenus Greene var. *inamoenus* **[14,15,2,5]** D, L, R; 6700–9750′; **J, U;** af, mc, mm, mr, ra, sf.
Ranunculus macounii Britton **[17,17,3,1]** D, L, R; 6000–10020′; **J, U;** mc, ml, mm, mr, ms, pp, ra.
Ranunculus ranunculinus (Nutt.) Rydb. **[1,-,-,-]** L; 8960′; **J;** mc.
!* *Ranunculus repens* L. **[1,-,-,-]** D; 7490′; **J;** mr.
Ranunculus sceleratus L. var. *multifidus* Nutt. **[1,-,2,-]** D, L; 5400–5800′; **J, G;** fr.
Ranunculus uncinatus D. Don ex G. Don **[5,-,-,4]** R; 5360–9720′; **J, U;** af, mc, mr.
[*Ranunculus uncinatus* var. *earlei* (Greene) L.D. Benson]
Thalictrum fendleri Engelm. ex A. Gray **[26,13,2,8]** D, L, R; 6975–9950′; **J, U;** af, br, mc, mm, mr, ms, pp, ra, sf.
Trautvetteria caroliniensis (Walter) Vail **[9,2,2,1]** D, L, R; 8400–10000′; **J, U;** af, mc, mm, mr, sf.

Rhamnaceae

Ceanothus fendleri A. Gray **[21,9,2,4]** D, L, R; 6900–9600′; **J, U;** br, mc, ms, pp, ra.

Rosaceae

Agrimonia gryposepala Wallr. **[4,-,-,-]** D, R; 7050–8150′; **J;** mc, mm, mr.
Agrimonia striata Michx. **[4,3,3,-]** D, L, R; 7960–8900′; **J;** mm, mr.
Amelanchier alnifolia (Nutt.) Nutt. ex Roem. var. *alnifolia* **[23,2,2,3]** D, L, R; 6600–10150′; **J, U;** af, mc, mm, mr, ms, pp, sf.
Amelanchier utahensis Koehne **[1,-,-,-]** D; 7940–8050′; **J;** ra.
Cercocarpus montanus Raf. var. *montanus* **[28,2,7,37]** D, L, R, S, T; 5600–9450′; **J, G, P, U;** br, ds, fr, mc, mr, ms, pj, pp.
Crataegus erythropoda Ashe **[-,-,4,2]** D, L, R, S; 6500–8350′; **J, U;** mr, ms.
Crataegus macracantha Lodd. ex Loud. var. *occidentalis* (Britton) Eggleston **[1,-,-,-]** D; 7100′; **J;** mr.
Dasiphora fruticosa (L.) Rydb. **[17,16,1,25]** D, R; 7475–10900′; **J, U;** af, mc, mm, mr.
Fallugia paradoxa (D. Don) Endl. ex Torr. **[18,-,6,20]** D, L, R, S, T; 5550–8475′; **J, G, P, U;** ds, fr, ms, pj, pp, ra.
Fragaria vesca L. **[25,31,4,3]** D, L, R; 6450–10150′; **J, U;** af, br, mc, mm, mr, ms, pp, ra, sf.
Fragaria virginiana Mill. **[27,21,2,6]** D, L, R; 6975–10300′; **J, U;** af, br, mc, mm, mr, ms, pp, ra, sf.
Geum aleppicum Jacq. **[6,3,2,-]** D, L, R; 7800–8900′; **J;** mc, ml, mm, mr, pp.
Geum macrophyllum Willd. var. *perincisum* (Rydb.) Raup **[12,14,5,6]** D, L, R; 6600–10900′; **J, U;** af, mc, mm, mr.
Geum rivale L. **[-,N,1,-]** D, L; 8000–9600′; **J;** mc, mr.
Geum triflorum Pursh var. *ciliatum* (Pursh) Fass. **[-,2,2,2]** D, R; 8530–9850′; **J, U;** mc, mm, ms, ra.
! *Geum triflorum* Pursh var. *triflorum* **[1,-,-,-]** D; 8500′; **J;** mr.
Holodiscus dumosus (Nutt. ex Hook.) A. Heller **[13,16,4,10]** D, L, R, T; 6000–10230′; **J, P, U;** af, br, mc, mm, mr, ms, pj, sf.
* *Malus pumila* Mill. **[2,1,1,-]** D, R; 6000–8300′; **J;** fr, mm, mr, ra.
Physocarpus monogynus (Torr.) J.M. Coult. **[13,8,4,-]** D, L, R; 6400–10000′; **J, U;** af, br, mc, mm, mr, ms.
Potentilla anserina L. **[9,12,2,7]** D, L, R; 5550–9200′; **J, U;** fr, ml, mm, mr.
Potentilla arguta Pursh var. *convallaria* (Rydb.) T.F. Wolf **[2,1,1,-]** D; 6500–8050′; **J;** br, mc, mr, ra.
Potentilla concinna Richardson var. *bicrenata* (Rydb.) S.L. Welsh & B.C. Johnst. **[-,-,-,6]** R; 7050–8550′; **U;** mr, pp, ra.
[*Potentilla concinna*]
Potentilla concinna Richardson var. *concinna* **[-,2,-,-]** D; 10340–11150′; **J;** mm, sf.
Potentilla crinita A. Gray var. *crinita* **[1,-,2,-]** D, L, R; 7310′; **J;** ds, pp.
Potentilla diversifolia Lehm. var. *diversifolia* **[-,3,-,3]** D, R; 8625–10100′; **J, U;** af, mm, mr.
Potentilla gracilis Douglas ex Hook. var. *glabrata* (Lehm.) C.L. Hitchc. **[1,-,-,-]** R; 8060′; **J;** mr.
Potentilla gracilis Douglas ex Hook. var. *pulcherrima* (Lehm.) Fernald **[23,19,5,10]** D, L, R; 7675–11150′; **J, U;** af, mc, ml, mm, mr, ms, pp, ra, sf.
Potentilla hippiana Lehm. var. *hippiana* **[29,62,3,24]** D, L, R; 6975–11150′; **J, U;** af, br, ds, mc, mm, mr, ms, pp, ra, sf.
× *Potentilla hippiana* Lehm. × *P. gracilis* Douglas ex Hook. var. *pulcherrima* (Lehm.) Fernald **[4,-,-,3]** D, L, R; 8240–10900′; **J, U;** br, mm, mr, ra.
Potentilla norvegica L. ssp. *monspeliensis* (L.) Asch. & Graebn. **[9,33,3,2]** D, L, R; 5700–10230′; **J, U;** af, br, mc, mm, mr, ms, pp, ra.
[*Potentilla norvegica*]
Potentilla paradoxa Nutt. **[-,-,2,-]** D; 5360–5400′; **J;** fr.
Potentilla pensylvanica L. var. *pensylvanica* **[7,18,-,8]** D, R, T; 7300–10230′; **J, P, U;** br, ds, mc, mm, mr, ms, pp, ra.
Potentilla rivalis Nutt. **[1,-,-,1]** L, T; 5400–7100′; **G, P;** fr, ml.
Prunus americana Marshall **[-,-,2,2]** D, R; 6100–8000′; **J, U;** fr, mr, ra.
!* *Prunus persica* (L.) Batsch **[1,1,-,-]** D; 7250–8080′; **J;** ml, ra.
Prunus virginiana L. var. *melanocarpa* (A. Nelson) Sarg. **[41,8,6,9]** D, L, R, T; 5860–9600′; **J, G, P, U;** af, br, ds, fr, mc, mm, mr, ms, pp, ra.
Purshia stansburiana (Torr.) Henr. **[1,-,-,-]** D; 7000–7400′; **J;** pj.
Purshia tridentata (Pursh) DC. **[1,-,-,-]** R; 7400–8600′; **J;** pp.
Rosa acicularis Lindley var. *sayana* Erlanson **[10,2,-,10]** D, L, R; 5940–9500′; **J, G, U;** mc, mm, mr, ms, pp, ra.
Rosa arkansana Porter var. *arkansana* **[24,-,-,-]** D, R; 6320–8900′; **J;** br, ds, mm, mr, ms, pp, ra.

Rosa arkansana Porter var. *suffulta* (Greene) Cockerell **[1,-,-,-]** D; 8260'; **J;** ms.

Rosa nutkana C. Presl **[6,7,-,4]** D, R; 8025–9400'; **J, U;** af, mc, mm, mr, ms, pp, ra.
[*Rosa nutkana* var. *hispida* Fernald]

Rosa woodsii Lindl. var. *ultramontana* (S. Watson) Jeps. **[10,3,6,1]** D, L, R; 6000–9425'; **J, U;** fr, mc, mm, mr, ms, pp, ra.

Rubus idaeus L. var. *aculeatissimus* Regel & Tiling **[38,20,5,3]** D, L, R; 6000–10940'; **J, U;** af, br, mc, mm, mr, ms, pp, ra, sf.
[*Rubus idaeus* var. *strigosus* (Michx.) Maxim.]

Rubus parviflorus Nutt. var. *parviflorus* **[27,13,3,4]** D, L, R; 6800–10900'; **J, U;** af, br, mc, mm, mr, ms, pp, ra, sf.

* *Sanguisorba minor* Scop. ssp. *muricata* Briq. **[1,-,-,-]** D; 6200'; **J;** ra.
[*Sanguisorba minor* ssp. *balearica* (Bourg. ex Nyman) M. Garmendia & C. Navarro]

Sibbaldia procumbens L. **[-,-,-,1]** R; 10350–10940'; **U;** mm.

Sorbus dumosa Greene **[2,-,-,-]** D; 8400–9200'; **J;** af, mr.

Rubiaceae

* *Galium aparine* L. var. *echinospermum* (Wallr.) Farw. **[-,-,6,-]** D; 6000–9400'; **J;** mc, mr.
[*Galium aparine*]

Galium boreale L. **[13,10,3,14]** D, L, R; 7200–10600'; **J, U;** af, br, mc, mm, mr, ms, pp.

Galium fendleri A. Gray **[4,-,1,-]** D, L; 6150–8400'; **J;** br, mc, mr, ms, pp.

Galium mexicanum Kunth var. *asperrimum* (A. Gray) Higgins & S.L. Welsh **[23,29,1,-]** D, L, R; 6500–10330'; **J;** br, mc, mm, mr, ra, sf.

Galium trifidum L. var. *subbiflorum* Wiegand **[3,5,-,2]** D, R; 7920–10940'; **J, U;** mc, mr, pp, ra, sf.

Galium triflorum Michx. **[8,-,2,2]** D, R; 6955–9150'; **J, U;** af, mc, mm, mr.

Houstonia rubra Cav. **[3,-,-,5]** R; 5800–6800'; **J, P, U;** ds, fr, pg, pj.

Rutaceae

Ptelea trifoliata L. **[10,-,4,1]** D, L, R, S, T; 5600–8475'; **J, G, P;** ds, fr, mr, ms, pp, ra.
[*Ptelea trifoliata* infrataxa]

Salicaceae

× *Populus* ×*acuminata* Rydb. **[1,-,1,-]** D, R; 6000–7400'; **J;** mr.

* *Populus alba* L. **[-,-,1,-]** D; 6000'; **J;** ra. [Individual plant eradicated]

Populus angustifolia E. James **[17,1,2,21]** D, L, R; 5600–9000'; **J, G, P, U;** br, fr, mr, ms, ra.

Populus deltoides W. Bartram ex Marshall var. *wislizenii* (S. Watson) Dorn **[16,-,1,4]** D, L, R, S; 5470–7475'; **J, G, P, U;** fr, mr, ra.

Populus tremuloides Michx. **[48,27,2,26]** D, L, R; 6975–10700'; **J, P, U;** af, br, mc, mm, mr, pp, ra, sf.

◆ *Salix arizonica* Dorn **[1,-,-,-]** R; 9300–10140'; **J;** mc.

Salix bebbiana Sarg. **[16,8,2,1]** D, L, R; 6975–9725'; **J, U;** mc, mm, mr.

Salix boothii Dorn [**RM**-*Dorn 8831*] R; **J.**

Salix drummondiana Barratt ex Hook. **[4,-,-,2]** D, L, R; 8275–9830'; **J, U;** ml, mm, mr.

Salix eriocephala Michx. var. *ligulifolia* (C.R. Ball) Dorn **[5,4,-,-]** D, R; 7950–9190'; **J;** mc, mm, mr.

Salix exigua Nutt. var. *exigua* **[22,1,7,6]** D, L, R, S; 5400–8375'; **J, G, U;** fr, mm, mr, ra.

Salix gooddingii C.R. Ball **[2,-,-,-]** L, S; 5400–5800'; **G;** fr.

Salix irrorata Andersson **[6,1,4,-]** D, L; 5400–7950'; **J, G;** fr, mm, mr, ra.

Salix lasiandra Benth. var. *caudata* (Nutt.) Sudw. **[-,-,-,8]** R; 7050–9800'; **U;** fr, mr.
[Salix lucida Muhl. ssp. caudata (Nutt.) Murray]

Salix lasiandra Benth. var. *lasiandra* **[4,1,-,-]** D, R; 7100–8000'; **J, U;** mm, mr.
[*Salix lucida* Muhl. ssp. *lasiandra* (Benth.) Murray]

Salix monticola Bebb **[3,-,-,2]** D, R; 8350–9830'; **J, U;** mm, mr.

Salix planifolia Pursh var. *planifolia* **[-,-,-,1]** R; 10350–10940'; **U;** mr.

Salix scouleriana Barratt ex Hook. **[7,7,-,5]** D, R; 7950–10250'; **J, P, U;** af, mc, mm, mr, ms, pp, ra.

Salix wolfii Bebb var. *wolfii* [**RM**-*Dorn 8847*] R; **U.**

Santalaceae (Viscaceae)

Arceuthobium divaricatum Engelm. **[2,-,-,4]** D, R, T; 6400–7750'; **J, P, U;** pj, pp.

Arceuthobium douglasii Engelm. **[-,6,-,2]** D, R, T; 8450–10650'; **J, P, U;** mc.

Arceuthobium vaginatum (Willd.) J. Presl var. *cryptopodium* (Engelm.) Cronquist **[6,3,1,7]** D, L, R; 7300–9340'; **J, U;** mc, pj, pp.

Comandra umbellata (L.) Nutt. var. *pallida* (A. DC.) M.E. Jones **[9,1,2,10]** D, R, T; 5500–9600'; **J, P, U;** ds, fr, mc, ms, pj, pp, ra.

Phoradendron juniperinum Engelm. var. *juniperinum* **[4,-,3,6]** D, R, T; 5500–7950'; **J, G, P, U;** fr, pj, pp.

Saururaceae

Anemopsis californica (Nutt.) Hook. & Arn. **[-,-,3,-]** D, S; 5350'; **J;** ml.

Saxifragaceae

Heuchera parvifolia Nutt. ex Torr. & A. Gray **[6,3,2,12]** D, R, T; 6000–9720'; **J, P, U;** br, mc, mm, mr, ms, pj.

Heuchera rubescens Torr. **[1,-,-,-]** D; 6850–7100'; **J;** mr.

Lithophragma tenellum Nutt. [**UNM**-*Heil 8812*] R; **U.**

Mitella pentandra Hook. [**UNM**-*Fleck s.n.*] R; **J.**

Saxifraga bronchialis L. var. *austromontana* (Wiegand) Piper ex G.N. Jones **[3,8,2,1]** D, L, R; 7960–11150'; **J, U;** mc, mr, ms, pp, sf.

Saxifraga odontoloma Piper **[2,-,-,1]** R; 9300–11000'; **J, U;** mc, mr, sf.

Saxifraga rhomboidea Greene **[1,2,1,2]** D, R; 8500–10600'; **J, U;** mc, mm, mr.

Scrophulariaceae (see also Orobanchaceae, Plantaginaceae)

Scrophularia lanceolata Pursh **[1,-,-,2]** R; 8200–9680'; **J, U;** mc, mm.

* *Verbascum thapsus* L. **[7,11,2,4]** D, L, R; 6300–9800′; **J, G, U;** af, br, fr, mm, mr, ms, pp, ra.

Simaroubaceae

* *Ailanthus altissima* (Mill.) Swingle **[2,-,2,-]** D, L, R; 5400–6000′; **G;** fr, ra.

Solanaceae

Chamaesaracha coronopus (Dunal) A. Gray **[2,-,1,3]** R; 5500–6300′; **J, G, P, U;** fr, pg, pj, ra.

* *Datura quercifolia* Kunth **[-,-,1,-]** D; 5800′; **J;** pj.

Datura wrightii Regel **[1,-,2,-]** L; 5500–6000′; **J, G;** fr, ra.

* •*Hyoscyamus niger* L. **[-,-,-,4]** R, T; 7600–8740′; **P, U;** ds, ml, pj, ra.

Lycium pallidum Miers **[9,-,3,4]** D, L, R, S, T; 5760–8150′; **J, G, P, U;** ds, fr, mm, pj, ra.

Nicotiana attenuata Torr. ex S. Watson [**UNM**-*Bell s.n.*] D; **J.**

Physalis hederifolia A. Gray var. *comata* (Rydb.) Waterf. **[-,-,-,2]** R, T; 6550–7300′; **P, U;** pj, ra.

Physalis hederifolia A. Gray var. *fendleri* (A. Gray) Cronquist **[3,-,3,7]** R, S, T; 5500–6880′; **J, G, P, U;** ds, pj, pp, ra.

Physalis longifolia Nutt. var. *longifolia* **[1,-,2,-]** D, L; 5400–6100′; **J, G;** fr.

Physalis subulata Rydb. var. *neomexicana* (Rydb.) Waterf. ex Kartesz & Gandhi **[1,-,1,-]** L, T; 6300–6900′; **G, P;** pp, ra.
[*Physalis foetens* Poir. var. *neomexicana* (Rydb.) Waterf. ex Kartesz & Gandhi]

Solanum americanum Mill. **[-,-,1,-]** D; 6500′; **J;** fr.
[*Solanum nigrum* L.]

* *Solanum dulcamara* L. **[1,-,-,-]** L; 6525′; **J;** ra.

Solanum elaeagnifolium Cav. **[4,-,1,2]** D, L, R; 5550–7000′; **J, G, U;** fr, pj, ra.

Solanum jamesii Torr. **[-,-,3,4]** D, L, R, T; 6200–8150′; **J, P, U;** br, ds, pj, pp.

* *Solanum physalifolium* Rusby var. *nitidibaccatum* (Bitter) Edmonds **[-,-,1,-]** L; 6650′; **J;** ra.
[*Solanum sarrachoides* Sendtner]

* *Solanum ptycanthum* Dunal ex DC. **[1,2,-,-]** D; 8050–8900′; **J;** mm, mr.
[*Solanum nigrum* L.]

* *Solanum triflorum* Nutt. **[1,4,1,6]** D, R, T; 5500–8750′; **J, P, U;** br, ds, fr, mm, pp, ra.

Sparganiaceae

Sparganium angustifolium Michx. **[1,2,-,1]** D, R; 8400–10020′; **J, U;** mr.

Sparganium emersum Rehmann **[-,1,-,1]** D, R; 8625–9150′; **J, U;** mr.

Tamaricaceae

* •*Tamarix chinensis* Lour. **[12,-,3,3]** D, L, R, S; 5300–7200′; **J, G, U;** fr, mr.

Typhaceae

Typha latifolia L. **[6,1,2,1]** D, L, R; 5400–9150′; **J, G, U;** fr, ml, mr.

Ulmaceae

* •*Ulmus pumila* L. **[15,1,1,1]** D, L, R, S; 5470–8080′; **J, G, P, U;** fr, mm, mr, pj, pp, ra.

Urticaceae

Parietaria pensylvanica Muhl. ex Willd. **[-,1,-,-]** D; 8700′; **J;** mr.

Urtica dioica L. var. *procera* (Muhl. ex Willd.) Wedd. **[23,30,1,12]** D, R; 6600–10100′; **J, U;** af, br, mc, ml, mm, mr, pp, ra, sf.
[*Urtica dioica* ssp. *gracilis* (Aiton) Selander]

Verbenaceae

Glandularia bipinnatifida (Nutt.) Nutt. var. *bipinnatifida* **[6,-,2,-]** D, L, R, S; 5500–6900′; **J, G;** ds, fr, pj, pp, ra.

Verbena bracteata Lag. & Rodr. **[22,4,2,13]** D, L, R, T; 5500–9050′; **J, G, P, U;** br, ds, fr, mc, mm, mr, pg, pj, pp, ra.

Verbena hastata L. **[1,-,-,-]** L; 5650′; **J;** mr.

Verbena macdougalii A. Heller **[14,1,1,1]** D, L, R, T; 6655–8400′; **J, P, U;** af, ds, mm, mr, pj, pp, ra.

Violaceae

Viola adunca J.E. Sm. **[10,13,3,6]** D, L, R; 6700–10675′; **J, U;** af, mc, mm, mr, sf.

Viola canadensis L. **[33,18,1,3]** D, R; 6300–10330′; **J, U;** af, br, mc, mm, mr, pp, ra, sf.

Viola nephrophylla Greene **[-,-,1,2]** D, R; 6600–9800′; **J, U;** mr.

Viola pedatifida G. Don **[-,1,-,-]** D; 8500′; **J;** mr.
[*Viola palmata* L.]

Vitaceae

Parthenocissus vitacea (Knerr) Hitchc. **[5,-,1,1]** D, R, T; 5900–7475′; **J, P;** fr, mr, ra.

Vitis arizonica Engelm. **[6,-,2,-]** D, L; 5460–6875′; **J, G;** fr, mr, ra.

Zannichelliaceae

Zannichellia palustris L. **[2,2,-,-]** D, L; 5600–8620′; **J, G;** fr, ml, mr.

Zygophyllaceae

Kallstroemia parviflora Norton **[-,-,1,-]** D; 5600′; **J;** pj.

* *Tribulus terrestris* L. **[5,-,1,3]** L, R, S, T; 5550–6300′; **J, G, P, U;** ds, fr, pj, ra.

ACKNOWLEDGMENTS

Staff and associates of Bandelier National Monument, Bureau of Land Management (Taos District), Carson National Forest, Santa Fe National Forest, and Valles Caldera National Preserve are thanked for funding of the projects, the use of facilities, and assistance in numerous other ways. Key individuals include Craig D. Allen, Chirre Keckler, Randy McKee, Linus Meyer, and Bob Parmenter.

Assistance in the field was provided by Jonathan Coop, James Fowler, Andrew Hipp, Mark Larson, and Robert Peters.

The following individuals are thanked for the identification or verification of specimens: Jennifer Acker-field, Kelly Allred, Duane Atwood, Mary Barkworth, Karen Clary, Robert D. Dorn, Bill Jennings, Bernadette Kuhn, Tim Lowrey, Stewart Markow, Bob Sivinski, and Debra Trock. We also thank Tim Hogan and Bob Sivinski for reviewing the manuscript.

We acknowledge the valuable contribution by the graduate committees that included Greg Brown, Dave McDonald, and Steve Prager. Alex Buerkle, Larry Schmidt, and Jeff Lockhart also provided assistance. Graduate students in the M.S. floristics program and other botany students provided invaluable assistance, support, and inspiration.

Finally, Tim Lowrey, Director of the University of New Mexico Herbarium, and Jane Mygatt, Senior Collection Manager, provided access to the collection and to the database.

REFERENCES

Allen, C.D. 2001. Fire and vegetation history of the Jemez Mountains. In: P.S. Johnson, ed. Water, watersheds, and land use in New Mexico: impacts of population growth on natural resources, Santa Fe region 2001. New Mexico Bur. Mines Mineral Res., Socorro. Pp. 29–33.

Allred, K.W. 2008. Flora Neomexicana I: the vascular plants of New Mexico. An annotated checklist to the names of vascular plants with synonymy and bibliography. Lulu Enterprises, Inc., Morrisville, North Carolina.

Anschueta, K.F. and T. Merlan. 2007. More than a scenic mountain landscape: Valles Caldera National Preserve land use history. Forest Serv. Rocky Mountain Res. Sta. Gen. Tech. Rep. RMRS-GTR-196. Fort Collins, Colorado.

Ash, S.R. 1974. Upper Triassic plants of Cañon del Cobre, New Mexico. In: C.T. Siemers, ed. Ghost Ranch, central northern New Mexico. New Mexico Geological Society, 25th Field Conference. Pp. 179–184.

Bailey, R.A. and R.L. Smith. 1978. Guide to the Jemez Mountains and Española Basin. In: J.W. Hawley, ed. Guidebook to Rio Grande Rift in New Mexico and Colorado. New Mexico Bur. Mines Mineral Res., Cir. 163, Socorro. Pp. 184–196.

Bingler, E.C. 1968. Geology and mineral resources of Rio Arriba County, New Mexico. New Mexico Inst. Mining Tech. Bull. 91, Socorro.

Breshears, D.D. (and 12 others). 2005. Regional vegetation die-off in response to global-change-type drought. Proc. Natl. Acad. Sci. 102:15144–15148.

Brown, D.E. 1994a. Great Basin montane scrubland. In: D.E. Brown, ed. Biotic communities: southwestern United States and northwestern Mexico. Univ. Utah Press, Salt Lake City. Pp. 83–84.

Brown, D.E. 1994b. Montane meadow grassland. In: D.E. Brown, ed. Biotic communities: southwestern United States and northwestern Mexico. Univ. Utah Press, Salt Lake City. Pp. 113–114.

Chronic, H. 1987. Roadside geology of New Mexico. Mountain Press Publ., Missoula, Montana.

Cronk, Q. and J. Fuller. 1995. Plant invaders: the threat to natural ecosystems. Chapman & Hall, New York.

Daubenmire, R.F. 1943. Vegetational zonation in the Rocky Mountains. Bot. Rev. 9:325–393.

DeVelice, R.L., J.A. Ludwig, W.H. Moir, and F. Ronco, Jr. 1986. A classification of forest habitat types of northern New Mexico and southern Colorado. Forest Ser. Rocky Mountain Forest Range Exp. Sta. Gen. Tech. Rep. RM-131.

Dick-Peddie, W.A. 1993. New Mexico vegetation: past, present, and future. Univ. New Mexico Press, Albuquerque.

Eisenhood, B. 1979. Precipitation. In: J.L. Williams and P.E. McAllister, eds. New Mexico in maps. Tech. Appl. Cent., Univ. New Mexico, Albuquerque.

Fenneman, N.M. 1931. Physiography of western United States. McGraw-Hill Book Co., New York.

Flora of North America Editorial Committee, ed. 1993+. Flora of North America north of Mexico. Oxford Univ. Press, New York, Oxford.

Goff, G.F., G.A. Dawson, and J.J. Rochow. 1982. Site examination for threatened and endangered plant species. Environm. Managem. 6:307–316.

Goff, F., B.S. Kues, M.A. Rogers, L.D. McFadden, and J.N. Gardner. 1996. The Jemez Mountains Region, New Mexico Geol. Soc. 47th Ann. Field Conf., Socorro.

Governor's Drought Task Force. 2008. URL: www.ose.state.nm.us/DroughtTaskForce/.

Hartman, R.L. 1992. The Rocky Mountain Herbarium, associated floristics inventory, and the Flora of the Rocky Mountains project. J. Idaho Acad. Sci. 28:22–43.

Hartman, R.L. and B.E. Nelson. 2001. A checklist of the vascular plants of Colorado. Generic circumscriptions largely traditional; relevant names from regional floras and checklists included with explicit attribution. URL: http://www.rmh.uwyo.edu.

Hartman, R.L. and B.E. Nelson. 2005. General floristic survey of the Valles Caldera National Preserve, New Mexico. Report on field seasons 2001, 2002, 2003, 2004. To: U.S. Geol. Surv., Biol. Res. Div. (Order no. 02MESA1023, Refer. no. 02330201023).

Hartman, R.L. and B.E. Nelson. 2008. General information for floristics proposals. [The Boiler Plate]. 12 pp. URL: www.rmh.uwyo.edu.

Hartman, R.L., B.E. Nelson, and B.S. Legeler. 2009. Rocky Mountain plant specimen database: URL: http://www.rmh.uwyo.edu.

Hartman, R.L., B. Reif, B.E. Nelson, and B. Jacobs. 2006. New vascular plant records for New Mexico. Sida 22:1225–1233.

Heil, K.D. and S.L. O'Kane, Jr. 2007. A preliminary catalog of the vascular plants of the Chama Land and Cattle Company–Frank Sims Ranch, Rio Arriba County, New Mexico. New Mexico Botanist Newslett. 41:1–6.

Jacobs, B.F. 1989. A flora of Bandelier National Monument. Report to the National Park Service, PX7029-8-0484. Bandelier National Monument, Los Alamos, New Mexico.

Kelley, S.A. 1990. Late Mesozoic to Cenozoic cooling history of the Sangre de Cristo Mountains, Colorado and New Mexico. In: P.W. Bauer, S.G. Lucas, C.K. Mawer, and W.C. McIntosh, eds. Tectonic development of the southern Sangre de Cristo Mountains, New Mexico. New Mexico Geol. Soc. Guidebook, 41st Ann. Field Conf., Socorro.

Kues, B.S., S.A. Kelly, and V.W. Lueth (eds.). 2006. Geology of the Jemez Range II. New Mexico Geol. Soc. Fall Field Conf. Guidebook 58. Socorro.

Larson, J.E. 2008. A floristic inventory of vascular plants of the Carson National Forest and vicinity, north-central New Mexico, M.S. thesis, Dept. Botany, Univ. Wyoming, Laramie.

Lipman, P.W. 1978. Northern Rift Guide 2, Alamosa, Colorado-Santa Fe, New Mexico: Antonito, Colorado, to Rio Grande Gorge, New Mexico. In: J.W. Hawley, ed. Guidebook to Rio Grande Rift in New Mexico and Colorado. New Mexico Bur. Mines Mineral Res., Cir. 163, Socorro. Pp. 36–41.

Martin, C. 2003. Valle Grande: a history of the Baca Location No. 1. Los Alamos, New Mexico. All Seasons Publ.

McGrath, J. 2005. Plant distribution reports: *Carex deweyana* Schweinitz (Cyperaceae). New Mexico Botanist Newslett. 33: 7.

Merola-Zwartjes, M. 2004. Chapter 4: Biodiversity, functional processes, and the ecological consequences of fragmentation in southwestern grasslands. In: D.M. Finch, ed. Assessment of grassland ecosystem conditions in the southwestern United States. Vol. 1. Forest Serv. Rocky Mountain Res. Sta. Gen. Tech. Rep. 134. Fort Collins, Colorado. Pp. 49–85.

Miller, D.M., T.H. Nilsen, and W.L. Bilobeau. 1992. Chapter 6: Late Cretaceous to early Eocene geologic evolution of the U.S. Cordillera. In: B.C. Burchfiel, P.W. Lipman, and M.L. Zoback, eds. The Cordilleran Orogen: coterminous U.S. The Geology of North America. Vol. G-3. Geol. Soc. Amer., Boulder, CO. Pp. 205–260.

Minckley, W.L. and D.E. Brown. 1994. Cold-Temperate Wetlands. In: D.E. Brown, ed. Biotic communities: southwestern United States and northwestern Mexico. Univ. Utah Press, Salt Lake City. Pp. 239–247.

Moir, W.H. 1993. Alpine tundra and coniferous forest. In: W.A. Dick-Peddie, ed. New Mexico Vegetation, past, present, and future. Univ. New Mexico Press, Albuquerque. Pp. 47–84.

Muehlberger, W.R. 1978. Frontal fault zone of northern Picuris Range. In: J.W. Hawley, ed. Guide book to Rio Grande Rift in New Mexico and Colorado. New Mexico Bur. Mines Mineral Res., Cir.163, Socorro. Pp. 44–45.

Muehlberger, W.R. and S. Muehlberger. 1982. Española-Chama-Taos: a climb through time. Scenic trips to the geologic past, no. 13. New Mexico Bur. Mines Mineral Res., Socorro.

Muldavin, E. and P. Tonne. 2003. A vegetation survey and preliminary ecological assessment of Valles Caldera National Preserve, New Mexico. Final report to: U.S. Geol. Surv., Biol. Res. Div.

National Climatic Data Center. 2009. Historic Palmer drought indices. URL: ncdc.noaa.gov/oa/climate/research/drought/palmer-maps/index.php.

Natural Heritage New Mexico. 2007. NHNM tracking list for vascular plants. Albuquerque. URL: nhnm.unm.edu/tracking/tracking general.php.

Natural Resources Conservation Service. 2008. The PLANTS database. USDA Nat. Plant Data Center, Baton Rouge, Louisiana. URL: plants.usda.gov.

New Mexico Bureau of Geology and Mineral Resources. 2003. Geol. map New Mexico, Scale 1:500,000. Socorro.

New Mexico Rare Plant Technical Council. 2008. New Mexico rare plants. Albuquerque URL: nmrareplants.unm.edu.

Osborn, N.L. 1966. A comparative floristic study of Mount Taylor and Redondo Peak, New Mexico. Ph.D. dissertation. Univ. New Mexico, Albuquerque.

Pase, C.P. and D.E. Brown. 1994a. Rocky Mountain (Petran) subalpine conifer forest. In: D.E. Brown, ed. Biotic communities: southwestern United States and northwestern Mexico. Univ. Utah Press, Salt Lake City. Pp. 37–39.

Pase, C.P. and D.E. Brown. 1994b. Rocky Mountain (Petran) and Madrean Montane Conifer Forest. In: D.E. Brown, ed. Biotic communities: southwestern United States and northwestern Mexico. Univ. Utah Press, Salt Lake City. Pp. 43–48.

Peet, R.K. 1988. Forests of the Rocky Mountains. In: M.G. Barbour and W.D. Billings, eds. North American terrestrial vegetation. Cambridge Univ. Press, New York. Pp. 63–102.

Raish, C. 2004. Historic and contemporary land use in southwestern grassland ecosystems. In: D.M. Finch, ed. Assessment of grassland ecosystem conditions in the southwestern United States. Vol. 1. Forest Serv. Rocky Mountain Res. Sta. Gen. Tech. Rep. 134. Fort Collins, Colorado. Pp. 86–119.

Randall, J. 1996. Weed control for the preservation of biological diversity. Weed Tech. 10:370–383.

Reif, B.P. 2006. A vascular plant inventory of the Santa Fe National Forest (including the Valles Caldera National Preserve) and vicinity, north-central New Mexico. M.S. thesis, Dept. of Botany, Univ. Wyoming, Laramie.

Redmond, K.T. 2003. Climate variability in the West: complex spatial structure associated with topography, and observational issues. In: W.M. Lewis, Jr., ed. Water and climate in the western United States. Univ. Press Colorado, Boulder. Pp. 29–48.

Ristau, T. 1998. Comparison of two techniques for assessing species richness in Allegheny hardwood forests. Abstract 111. In: Ecol. Soc. Amer. 83rd Annual Meeting, Baltimore, M.D.

Sheppard, P.R., A.C. Comrie, G.D. Packin, K. Angersbach, and M.K. Hughes. 1999. The climate of the Southwest. The climate assessment project for the Southwest, CLIMAS Rep. Ser. CL1-99. Univ. Arizona, Tucson.

Sivinski, R. 2008. Some observations on the dry, dehiscent-fruited Yuccas of New Mexico. New Mexico Botanist Newslett. 43:1–4.

Smith, C.T., A.J. Budding, and C.W. Pitrat. 1961. Geology of the southeastern part of the Chama Basin. New Mexico Inst. Mining Tech. Bull. 75, Soccoro.

Smith, R.L., R.A. Bailey, and C.S. Ross. 1970. Geologic map of the Jemez Mountains, New Mexico. U.S. Geol. Surv., Misc. Inves. Ser. Map I-571, Denver, Colorado.

U.S. Forest Service. 1997. Plant associations of Arizona and New Mexico. Vol. 1: Forests. Vol. 2: Woodlands, 3rd ed. Forest Serv. Southw. Reg., Albuquerque, New Mexico.

West, N.E. 1999. Juniper-pinyon savannas and woodlands of western North America. In: R.C. Anderson, J. S. Frahlish, J.M, Baskin, eds. Savannas, barrens, and rock outcrop plant communities of North America. Cambridge Univ. Press, New York. Pp. 288–308.

Whittaker, R.H. 1978. Classification of plant communities. W. Junk Publ., The Hague, Netherlands.

Wilcove, D.S., D. Rothstein, J. Dubow, A. Phillips, and E. Losos. 2000. Leading threats to biodiversity. In: B.A. Stein, L.S. Kutner, and J.S. Adams, eds. Precious heritage: the status of biodiversity in the United States. Oxford Univ. Press, New York. Pp. 239–254.

BOOK REVIEW

PAUL E. ROTHROCK. 2009. **Sedges of Indiana and the Adjacent States: The Non-Carex Species.** (ISBN 978-1-883362-14-0, hbk: alk. paper). Indiana Academy of Science, 140 N Senate Ave., Indianapolis, Indiana 46204-2207, U.S.A. (**Orders:** www.indianaacademyofscience.org/publications/special/, 1-317-205-5440, iaspublications@indy.rr.com). $45.00, 270 pp., 228 color photographs, 3 color maps, 4 b&w figures, color range maps for 88 species, 3 appendices, glossary, 6 1/4" × 9 1/4".

Regardless if you are an amateur or professional or if you browsed this book for 10 minutes or 10 hours, you will elicit the same response: **WOW!** Written by one of the best known sedge experts in the United States, this is easily one of the most incredible state treatments of non-Carex sedges ever written. The book is so well written, illustrated, and organized that it will set the standard for state compilations of specific plant groups for some time to come! The book is printed on thick, high quality, glossy paper and it is well bound with good stitching. This plus the attractive cover and stunning and sharp color photographs only contribute to the book's coffee book appearance. Combined with the extremely thorough, accurate, well written but concise text, it should be obvious to all readers why this book will be in high demand.

This publication follows a long list of outstanding natural history treatments for Indiana published by the Indiana Academy of Science that include *Orchids of Indiana* by Mike Homoya (1993), *Field Guide to Indiana Wildflowers* by Kay Yatskievych (2000), *Dragonflies of Indiana* by James Curry (2001), *Amphibians and Reptiles of Indiana* by Sherman Minton, Jr. (2001), and *101 Trees of Indiana* by Marion Jackson (2004). In the foreword, Indiana Academy of Science Publications Chairman Bill McKnight writes, "With this visually rich book, Paul Rothrock, who has studied Cyperaceae for many years, has provided a tool that will be profound assistance to curious amateur naturalists, as well as to gardeners and natural area and restoration biologists. This is, essentially, the overriding objective of all our books: to be attractive, technically accurate, and utilitarian to the interested amateur and professional in that field of study." Clearly, this objective is not only achieved but surpassed with this publication. The author ended his preface to the book by commenting, "As for beauty, these plants can reward the intent observer with graceful inflorescences, colorful spikelets, beautifully sculptured achenes, and *Bau Haus* functional design. My clear hope is that the text and photos that follow adequately capture some of this world and even point to some significant place for sedges in the practical arts." Given the exquisite and elegant design of this book and the excellent content, I emphatically predict that the author's wishes will be fully realized. Certainly one of the pluses of the book is that Dr. Rothrock received input and review from such renowned botanists as Dr. Anton Reznicek, Dr. Charles Bryson, Dr. S. Galen Smith, Dr. Gordon Tucker, Dr. Gerould Wilhelm, and Mike Homoya. Another plus is that the author referenced no less than 130 separate publications in providing supportive information for different chapters and species treatments.

The book contains several excellent introductory chapters and includes information on the natural regions and glacial boundaries of Indiana (with superb color illustrations); sedge identification, biology and morphology; scientific and common names of sedges; sedge habitats and distribution; dispersal and germination of sedge achenes; evolution of sedges; and even short sections on the economic importance of sedges (a much welcomed addition), nutrient uptake and relationships with mycorrhizal fungi, adaptation of sedges to saturated soils, and C_3 and C_4 metabolism.

Certainly one of the highlights of the book is that Dr. Rothrock used the "coefficients of conservatism" developed by F. Swink & G. Wilhelm in 1979 (*Plants of the Chicago Region*, 3rd. ed., Morton Arboretum, Lisle, Illinois) to assess the conservation status of sedges in Indiana. Rare sedges and the natural communities upon which they depend are continually threatened from various human impacts. For sedge enthusiasts who have a keen interest in endangered, threatened, or rare sedges and natural communities throughout the Midwest, treatments that attempt to establish some conservation value on potentially imperiled species is a welcomed and refreshing approach. Species with coefficients of conservatism values of 8–10 receive the highest value while those of 0–1 receive the lowest. It should be alarming and a concern to all readers of this book that of the 88 Indiana species covered by the author, nearly 50% have coefficients between 8 and 10. Hopefully by highlighting the high conservative values of Indiana sedges and the natural communities upon which they depend, the author will garner further support to protect, maintain, and manage these valuable natural resources.

Also provided in the introduction is a family description, a key to the genera of Cyperaceae in Indiana, and black and white illustrations of representative achenes of each genus as well as the achenes of all known species of *Eleocharis, Rhynchospora,* and *Scleria* documented for the state. Not only are the illustrations accurate but they are drawn to comparative scale and color among taxa and are further represented with a cross section.

Although the first 55 introductory pages could well serve as a natural history treatment on sedges, the outstanding treatments of 15 sedge genera and 88 species of non-Carex sedges are the meat and heart of the book. To increase the utility of the book, the author also briefly discusses 40 species of non-Carex sedges that are not known from Indiana but have been documented in the adjacent states of Kentucky, Illinois, Ohio, Michigan, and/or Wisconsin.

Taxonomy of species follows treatments provided in the *Flora of North America* accounts. All species treatments include a colored county range map that separates rarity into the following categories: 1) occasional to common and verified by herbarium voucher, 2)

(continued on page 968)

J. Bot. Res. Inst. Texas 3(2): 962. 2009

BERBERIS REPENS (BERBERIDACEAE) NEW AGAIN TO THE FLORA OF PENNSYLVANIA

Jerry G. Chmielewski

Slippery Rock University
Department of Biology
Slippery Rock, Pennsylvania 16057, U.S.A.
jerry.chmielewski@sru.edu

ABSTRACT

Berberis repens, a previously documented species from Pennsylvania, though most recently an excluded species from the state record, is reported to occur in a naturalized population. This species was collected from the margins of a woodlot in Butler County in western Pennsylvania.

RESUMEN

Berberis repens, una especie previamente documentada de Pennsylvania, más recientemente se creyó una especie excluida del estado, se cita de una población naturalizada. Esta especie se colectó en los márgenes de un bosquete en el condado de Butler en el oeste de Pennsylvania.

Berberis repens Lindl. creeping barberry, is a native, evergreen, low growing, perennial shrub of western North America that is commonly cultivated, though has become naturalized in parts of eastern North America. Typically upright to decumbent, the solitary stems which arise from rhizomes form colonies that are less than 40 cm tall. The inner bark is distinctly yellow. The alternate, holly-like leaves are petiolate and pinnately compound with 3–7 oval, spiny-toothed (6–14 on each side), bluish-green, leathery, leaflets which are minutely pappilose on the underside. These turn purplish in winter. Deep yellow, fragrant flowers occur in terminal, drooping racemes from May–June. These in turn are followed by grape-like, 1–4 seeded, dark bluish-purple berries which ripen from June–July (Bailey 1949; Whittemore 1997; Harris 2009; USDA Forest Service 2009). *Berberis repens* differs from *Berberis aquifolium* Pursh, with which it hybridizes when the two grow in proximity to each other, by the latter's greater height (to 2+ m), smooth underside of leaflets, number of leaflets (5–9) per compound leaf, and the number of teeth (10+ on each side) on leaflets (Bailey 1949; Whittemore 1997).

The native range of *B. repens* is the western U.S. east to Texas and Minnesota and British Columbia and Alberta in western Canada (Whittemore 1997). Further, the species has purportedly become naturalized in Ontario, Indiana, and Pennsylvania in eastern North America (USDA, NRCS 2009). Although commonly cited from a site in Northampton Co., PA based on a 1946 collection (Wherry et al. 1973; Rhoads & Klein 1993) this specimen likely represents a planting that persisted for a period of time after being cultivated, but never truly became established as part of the Pennsylvania flora (Grund, pers. comm.). For this reason the species was excluded (Block pers. comm.) from the most recent publication of the Pennsylvania flora (Rhoads and Block 2000).

A naturalized population of *B. repens* was observed in a woodlot adjacent to the water tower on the grounds of the Slippery Rock University campus during the summer of 2008. The population consists of four clustered, relatively young shoots, two of which were in flower, the others vegetative only. No fruits were observed later in the growing season. This said, immature fruits were present in mid-June of the current year. Based on the number of leaves alone the plants are presumed to be about 5–6 years old. Although I am unaware of a nearby cultivated seed source, presumably these shoots are a consequence of a bird introduction from a more or less locally cultivated specimen. The most commonly associated taxa included *Impatiens capensis* Meerb., *Liriodendron tulipifera* L., *Pilea pumila* (L.) A. Gray, *Rubus allegheniensis* Porter, and

J. Bot. Res. Inst. Texas 3(2): 963 – 964. 2009

Toxicodendron radicans (L.) Kuntze. Because the plants are still small only a single leaf was harvested in late winter.

Voucher specimen: **PENNSYLVANIA. Butler Co.:** Slippery Rock University campus, woodlot adjacent to water tower, 3 Mar 2009, *Chmielewski 3205* (SLRO).

ACKNOWLEDGMENTS

Both Steve Grund and Timothy Block are thanked for their insights into the Pennsylvania history of the *Berberis repens* collection from Northampton Co. Allison Cusick and Timothy Block are thanked for their helpful reviews of the manuscript.

REFERENCES

Bailey, L.H. 1949. Manual of cultivated plants most commonly grown in the continental United States and Canada. The MacMillan Co., New York.

Harrison, S. 2009. *Mahonia repens*. (http://www.usask.ca/agriculture/plantsci/classes/range/berberis.html). Accessed 30 January 2009.

Rhoads, A.F. and T.A. Block. 2000. The plants of Pennsylvania: an illustrated manual. University of Pennsylvania Press, Philadelphia, Pennsylvania.

Rhoads, A.F. and W.M. Klein, Jr. 1993. The vascular flora of Pennsylvania: an annotated checklist and atlas. American Philosophical Society, Philadelphia, Pennsylvania.

USDA, FOREST SERVICE. 2009. *Mahonia repens* (Lindl.) G. Don. (httl://www.fs.fed.us/global/iitf/pdf/shrubs/Mahonia%20repens.pdf). Accessed 30 January 2009.

USDA, NRCS. 2009. The PLANTS database. National Plant Data Center, Baton Rouge, LA. (http://plants.usda.gov/). Accessed 30 January 2009.

Wherry, E.T., J.M. Fogg, Jr., and H.E. Wahl. 1979. Atlas of the flora of Pennsylvania. Morris Arboretum of the University of Pennsylvania, Philadelphia, Pennsylvania.

Whittemore, A.T. 1997. *Berberis*. In: Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico. 12+ vols. New York and Oxford. 3:276–286.

BOUTELOUA CURTIPENDULA VAR. *TENUIS* (POACEAE: CYNODONTEAE), NEW TO TEXAS AND THE UNITED STATES AND A KEY TO *B. CURTIPENDULA* VARIETIES

Stephan L. Hatch
S.M. Tracy Herbarium (TAES)
Department of Ecosystem Science and Management
Texas A&M University
College Station, Texas 77843-2138, U.S.A.
s-hatch@tamu.edu

Maria Andrea Tomas
EE Rafaela, INTA
Ruta 34, km 227
CC 22, 2300, Rafaela, Sante Fe
ARGENTINA
matomas@rafaela.inta.gov.ar

Steven R. Archer
School of Natural Resources
University of Arizona
Tuscon, Arizona 85721-0043, U.S.A.
sarcher@ag.arizona.edu

ABSTRACT

The occurrence of *Bouteloua curtipendula* (Michx.) Torr. var. *tenuis* Gould & Kapadia is reported new to Texas and the United States. A key to *B. curtipendula* varieties in the U.S.A. is provided, along with digital photos of features distinguishing between them.

RESUMEN

Se reporta la ocurrencia de *Bouteloua curtipendula* (Michx.) Torr. var. *tenuis* Gould & Kapadia, nueva para Texas y los Estados Unidos. Se provee una clave para las variedades de *Bouteloua curtipendula* en E.E.U.U. y fotografías digitales mostrando características que las distinguen.

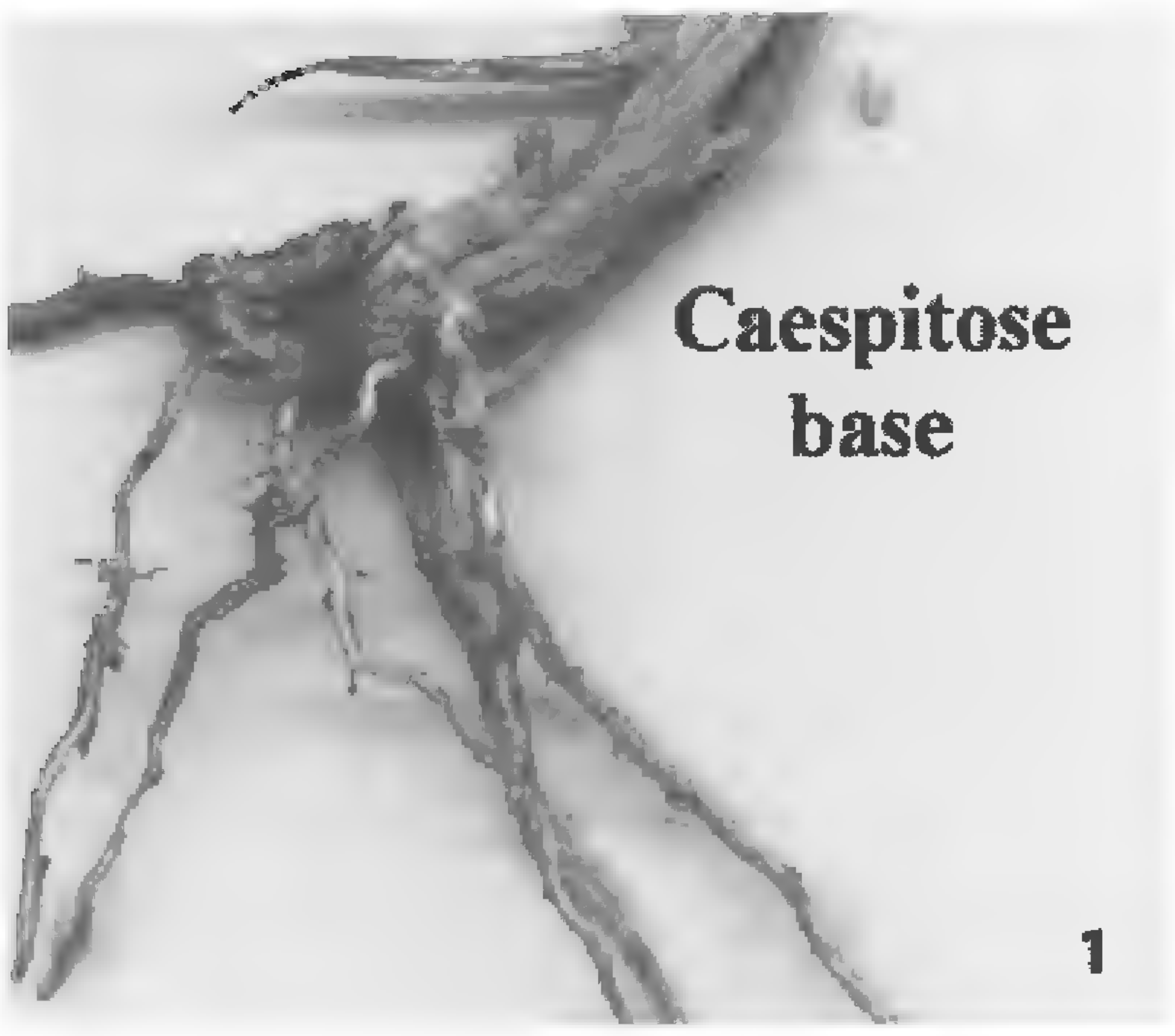
Prior to this report the occurrence of *Bouteloua curtipendula* (Michx.) Torr. var. *tenuis* Gould & Kapadia (CREEPING SIDEOATS GRAMA) in naturalized populations has not been recorded in Texas and the United States (Gould & Kapadia 1964; Gould 1979; Hatch et al. 1990; Allred 1993; Powell 1994; Jones at al. 1997; Wipff 2003; Hatch 2008; Flora of Texas Database 2008). Specimens of this taxon were collected in July 2001 but were not identified for a period of time because var. *tenuis* had not been described in botanical treatments of Texas or U.S.A. grasses.

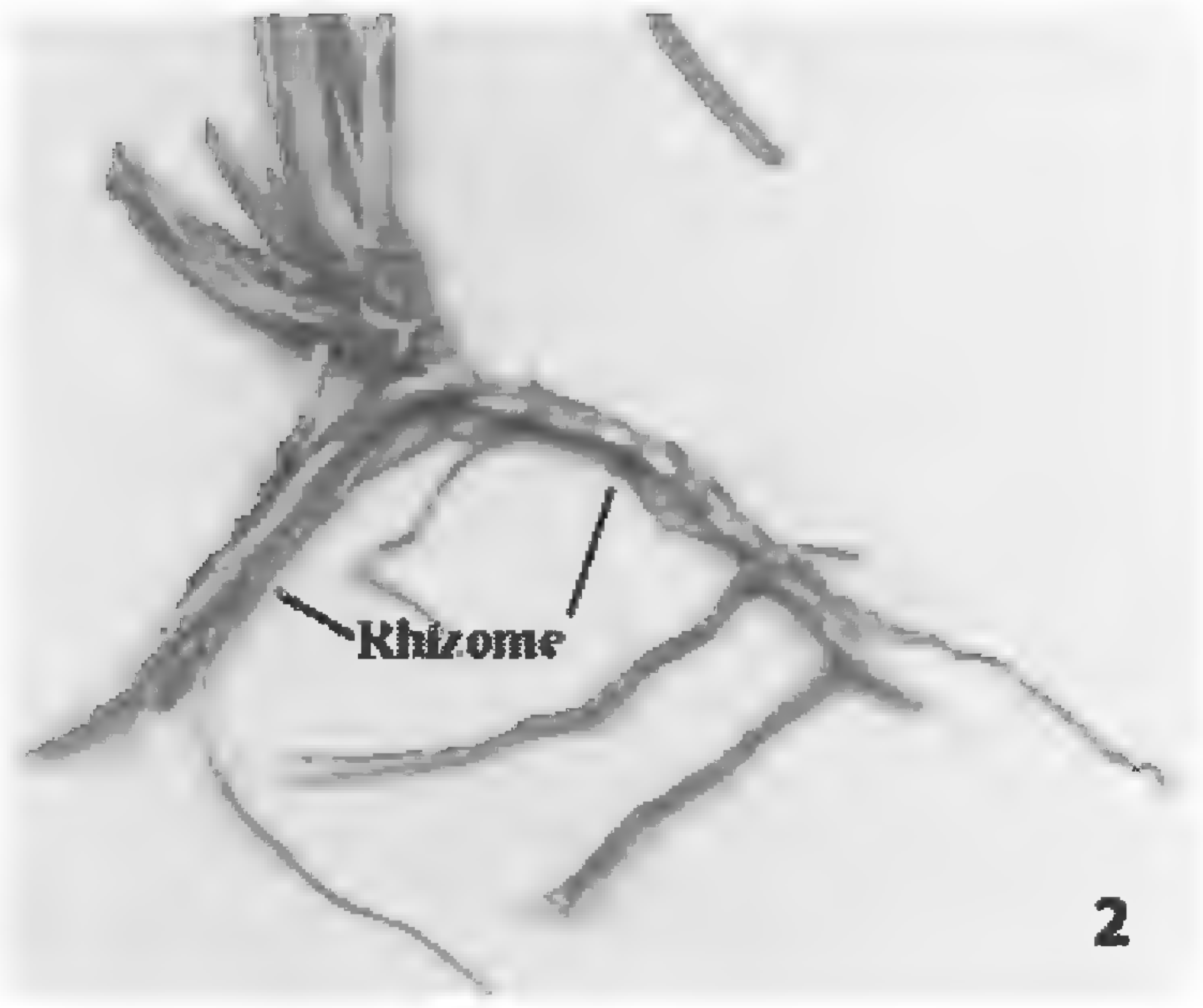
This grass was identified using Gould and Kapadia (1964) and verified using specimens in the Tracy Herbarium (TAES) from Mexico that included the holotype (*Gould 9000* TAES).

The three varieties of *B. curtipendula* are readily identified if specimens are collected carefully. Specimens with intact bases showing either a caespitose (bunchgrass) habit, or rhizomes, or stolons are critical to the identification process. The rhizomes must be more than short tillers prior to that structure becoming an erect stem. The varietal differences are noted in the key below and distinguishing morphological features are depicted in Figs. 1, 2, and 3. It is likely that var. *tenuis* in Texas established from seed dispersed by livestock (e.g., cattle, sheep, or goats) from populations in northern Mexico. A review of autecology of *B. curtipendula* can be found in Tomas (2004).

KEY TO *BOUTELOUA CURTIPENDULA* VARIETIES IN THE UNITED STATES

1. Plants caespitose or rarely with short knotty rhizomes ______ **B. curtipendula** var. **caespitosa**
1. Plant stoloniferous or with long rhizomes.
  2. Plants stoloniferous, rhizomes present or absent ______ **B. curtipendula** var. **tenuis**
  2. Plants with long rhizomes ______ **B. curtipendula** var. **curtipendula**





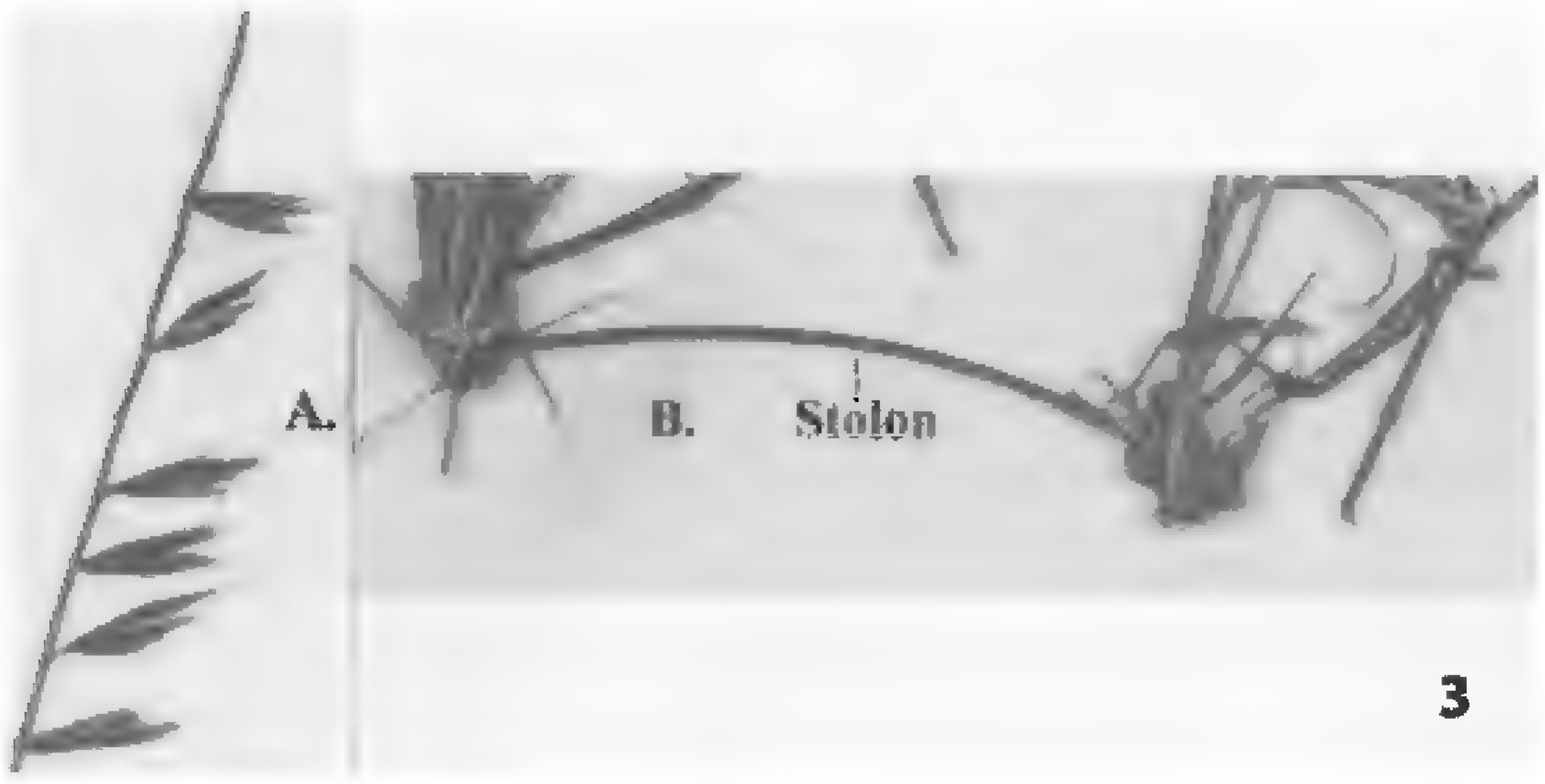


Fig. 1. Digital image of the caespitose base of *Bouteloua curtipendula* var. *caespitosa*.

Fig. 2. Digital image of the plant base of *Bouteloua curtipendula* var. *curtipendula*. Note the rhizomatous specimen base.

Fig. 3. Digital image of (A.) inflorescence and (B.) the plant base of *Bouteloua curtipendula* var. *tenuis*. Note the long stolon at the base.

Bouteloua curtipendula (Michx.) Torr. var. **tenuis** Gould & Kapadia, Gould & Kapadia, Brittonia 16:201–203. 1964. CREEPING SIDEOATS GRAMA.

Stoloniferous perennials. Culms ascending, slender rhizomes absent from Texas specimens (see discussion in Gould & Kapadia 1964). Leaves with long, thin but broad (3–5.5 mm wide) leaf blades. Panicles of 16–35 spicate primary branches; branches 1–3.5 cm long with 4–9 widely spaced spikelets. Spikelets 3.4–8 mm long, florets 2–4, apical ones rudimentary, rachilla not extending beyond upper floret, rudiment 3-awned; glumes 2, 1-veined, unequal, shorter or longer than first floret; lowermost lemmas 2.9–6.5 mm long, 3-veined, acute or trifid, mucro minute; lowermost paleas present. Flowering June to October.

Voucher specimens examined: **UNITED STATES: TEXAS. Sutton Co.:** TAES Sonora Experiment Station, Sonora, TX (31 18'N; 100 ° 28'W) oak juniper mottes with *B. curtipendula var. caespitosa*, *B. curtipendula* var. *curtipendula*, *Nassella leucotricha*, and *Carex planostachys*, *Tomas s.n.* (TAES). **MEXICO. Zacatecas:** 10 mi NW of Sombrerete, 30 Oct 1959, *Gould 9000* (holotype) (TAES).

REFERENCES

Allred, K.W. 1993. A field guide to the grasses of New Mexico. New Mexico State University. New Mexico Agricultural Experiment Station. Las Cruces.

Flora of Texas Database. 2008. University of Texas Herbarium, Plant Resources Center, Austin. < http://www.biosci.utexas.edu/prc/Tex.html>

Gould, F.W. 1979. The genus *Bouteloua* (Poaceae). Ann. Missouri Bot. Gard. 66:348–416.

Gould, F.W. and Z.J. Kapadia. 1964. Biosystematic studies in the *Bouteloua curtipendula* complex II. Taxonomy. Brittonia 16:182-207.

Hatch, S.L., K.N. Gandhi, and L.E. Brown. 1990. Checklist of the vascular plants of Texas. Texas Agricultural Experiment Station, College Station. MP 1655.

Hatch, S.L. 2008. Checklist of Texas grasses. <http://botany.csdl.tamu.edu/FLORA/taes/tracy/610/Checklist2008.pdf>

Jones, S.D., J.K. Wipff, and P.M. Montgomery. 1997. Vascular plants of Texas – a comprehensive checklist including synonymy, bibliography and index. University of Texas Press, Austin.

Powell, A.M. 1994. Grasses of the Trans-Pecos and adjacent areas. University of Texas Press, Austin.

Tomas, A. 2004. Ecological implications of genetic variation in *Bouteloua curtipendula* (Michx.) Torr. Ph.D. Dissertation, Texas A&M University.

Wipff, J.K. 2003. *Bouteloua*. In: Barkworth, M.E., K.M. Capels, S. Long, and M.B. Piep eds. Magnoliophyta: Commelinidae (inpart): Poaceae, part 2. Flora of North America North of Mexico, volume 25. Oxford University Press, New York. Pp 250–269.

BOOK REVIEW

(continued from page 962)

reported by Deam (1940: *Flora of Indiana*, Indiana Department of Conservation, Division of Forestry, Indianapolis), 3) infrequent but not listed as state rare, threatened, or endangered, and 4) state listed: rare, threatened, or endangered. Additionally, the overall status in Indiana is then compared in a regional color map to the status of the species in adjacent states. This is a fantastic approach because it not only depicts the county distribution but outlines the rarity of each species in Indiana and adjacent states.

Additional components of species account include scientific and common names; a short description; habitat, status; likely associates; wetness category following the U.S. Fish and Wildlife Service's designations [Reed, P., Jr. 1988. *National List of Plant Species That Occur in Wetlands: North Central* (Region 3) Biol. Rep. 88 (26.3), U.S. Fish and Wildlife Service, Washington, D.C.]; a bar graph outlining projected fruiting period; and observations on unique attributes, taxonomic interpretation, natural history, etc. One aspect covered that is often neglected in similar treatments is that the author provides information on known insect/sedge interactions. Each genus account is outlined with a color line and followed by a key to species in the genus. Artificial species groups in each genus are used for the larger genera. While some hard core taxonomists may be opposed to this approach, it will be welcomed by amateurs or those who are not as familiar with technical terms associated with sedge taxonomy. Most species known from Indiana are supported with 1–4 sharp photographs of habit, rhizomes, infloresence, and/or achenes.

For sedge enthusiasts who have ever struggled with pairs of species that are often difficult to distinguish, the author provides exhaustive and refreshing accounts helpful in separating the following: *Cyperus bipartitus* vs. *C. diandrus, Eleocharis flavescens* vs. *E. geniculata, Eleocharis erythropoda* vs. *E. palustris, Lipocarpha drummondii* vs. *L. micrantha, Schoenoplectus purshianus* vs. *S. smithii, Scirpus cyperinus* vs. *S. pedicellatus* and *Scleria muehlenbergia* vs. *S. reticularis.*

If all this was not enough, the author even found time to include a few historical tidbits in his species accounts. One in particular is my favorite: in his account on *Rhynchospora scirpoides,* Dr. Rothrock noted that famous botanist John Torrey completed his 500-page *Flora of the Northern and Middle Sections of the United States* on his wedding day!

There are three helpful appendices. Appendix A is checklist of all non-*Carex* sedge species known from Indiana, each with its annual or perennial habit, its coefficient of conservatism, and its wetness category. Appendix B covers taxonomic changes in species' scientific names, and Appendix C is an interesting key to Indiana's dozen most frequently encountered sedges excluding the genus *Carex*. While this may have limited utility for seasoned veterans and sedge experts, it will likely be useful for the casual observer or beginner on sedge identification.

I suppose with every book review you should try to find something to quibble about? This book is so well written, it is extremely difficult to find fault. I can only muster a few very minor comments. On page 21, there are two typos: *Cyperus echinatus* and *Scleria reticularis* have incorrect endings of "a" and "ta," respectively. It would have been helpful to address such words as aerenchyma, homoplasies, karyotype, monophyletic, and phytolith, etc. to the glossary. Such technical terms will not be immediately recognizable by the amateur or untrained botanist. Had there been sufficient time and space, some extra photographs of the 40 non-Carex species known from adjacent states would have quenched the thirst of sedge nuts like me who can never seem to get enough. But a book can only cover so much and such miniscule quibbles are hardly even worth mentioning. A copy of *Sedges of Indiana and the Adjacent States: The Non-Carex Species* should be on the shelf of every botanist in the Midwest and all sedge enthusiasts, regardless of experience. Given the quality of this book, we anxiously look forward to the author's upcoming treatment of the Indiana species of *Carex.—Paul M. McKenzie, Ph.D., Endangered Species Coordinator, U.S. Fish and Wildlife Service, 101 Park DeVille Dr.; Suite A, Columbia, Missouri 65203-0057, U.S.A.*

J. Bot. Res. Inst. Texas 3(2): 968. 2009

POLYGALA CYMOSA (POLYGONACEAE) NEW TO TEXAS

Michelle Pollard
Department of Biology
Baylor University
Waco, Texas 76798-7388, U.S.A.

Jason R. Singhurst
Wildlife Diversity Program
Texas Parks and Wildlife Department
4200 Smith School Road
Austin, Texas 78744, U.S.A.
jason.singhurst@tpwd.state.tx

Walter C. Holmes
Department of Biology
Baylor University
Waco, Texas 76798-7388, U.S.A.
walter_holmes@baylor.edu

ABSTRACT

Polygala cymosa Walter is reported as new to Texas.

RESUMEN

Se cita *Polygala cymosa* Walter como nueva para Texas.

The genus *Polygala*, commonly known as milkwort, includes about 550 species of worldwide distribution. These herbaceous perennials generally have simple entire leaves and inflorescences terminating the branches. Of the 26 species reported in Texas, ten species occur in the Pineywoods of East Texas.

Herbarium studies have resulted in the discovery of a specimen of *Polygala cymosa* Walter from the Pineywoods, which is herein reported as new to the state.

Voucher specimen: **TEXAS. Jasper Co.:** 7 mi S of Kirbyville, ca. 2 mi E of Hwy 96, ca. 0.2 mi N of end of unpaved road near Nichols Creek, wooded uplands, 17 Oct 1977, *Ajilvsgi 5505* (SMU).

Polygala cymosa, commonly known as tall pinebarren milkwort, is a plant of 40–120 cm in height. The flowers are lemon-yellow when fresh, and arise from branches emanating from a solitary stem. The linear basal leaves narrow distally and are 4–7 cm long. The flowers turn dark green upon drying. The species is known to occur in Alabama, Delaware, Florida, Georgia, Louisiana, Maryland, Mississippi, North Carolina, and South Carolina (USDA, NRCS 2009). Because this is the only known site of *P. cymosa* in Texas, and there is only one known site in western Louisiana (Thomas and Allen 1998), the species is considered to be a rare peripheral in the West Gulf Coastal Plain. The species is typically found in wet pinelands, swamps and ditches. The Texas site contains longleaf pine wetland savannas, slightly drier sandy clay upland longleaf pine savannas, and seepage bogs with *Sarracenia alata*.

Polygala nana and *P. ramosa* are the two other species of *Polygala* in East Texas with yellow perianth. The following key may be used to distinguish among the three species.

KEY TO THE YELLOW FLOWERED SPECIES OF *POLYGALA* OF THE PINEYWOODS OF TEXAS [ADAPTED FROM CORRELL AND JOHNSTON (1970) AND RADFORD ET AL. (1968)]

1. Plants 3–15 cm tall, scapose to semiscapose; racemes solitary at tips of stems, capitate to thick-cylindric, about as long as wide (9–20 mm)____________________ **P. nana**

1. Plants 10–120 cm tall, stems leafy; the racemes leafy, numerous, cymose, each usually about 2x longer than wide, in aggregate the inflorescence (20–)50–150 mm wide.

    2. Plants usually greater than 30 cm tall; basal leaves linear to linear-lanceolate, 3–7 cm long, stem leaves linear to filiform, gradually reduced above____________________ **P. cymosa**

J. Bot. Res. Inst. Texas 3(2): 969 – 970. 2009

2. Plants to 30 cm tall; basal leaves elliptic to spatulate, to 2.5 cm long, stem leaves linear, spatulate or elliptic, not reduced above __________ **P. ramosa**

Following are brief remarks on the distribution and characteristics of the species mentioned in the key. Information on *Polygala cymosa* is presented above.

Polygala nana (Michx.) DC. Southeast Texas (Angelina, Hardin, Jasper, Jefferson, Newton, Sabine, Tyler cos.); United States: Southern North Carolina to Arkansas, south to Florida to Texas. The species is well-marked by the single head-like raceme at the tip of scapelike stems and the licorice odor of the roots (earning it the common name of candy-root).

Polygala ramosa Elliott. Southeast Texas (Angelina, Chambers, Hardin, Houston, Jasper, Jefferson, Liberty, Newton, Orange, San Augustine, and Tyler cos.); United States: Coastal plain from Cape May Co., New Jersey, south to Florida, west to Texas. The species is characterized by the amply leaved stems, wide basal leaves, and height to about 30 cm.

ACKNOWLEDGMENTS

We wish to thank the curator of BRIT for access to the specimens that made this study possible.

REFERENCES

Correll, D.S. and M.C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner.

Redford, A.E., H.E. Ahles, and C.R. Bell. 1964. Manual of the vascular flora of the Carolinas. University of North Carolina Press, Chapel Hill.

Thomas, R.D. and C.A. Allen. 1998. Atlas of the vascular flora of Louisiana. Vol. III. Dicotyledons. Fabaceae-Zygophyllaceae. Louisiana Department of Wildlife and Fisheries, Baton Rouge.

USDA, NRCS. 2009. The PLANTS database (http://plants.usda.gov/plants). National Plant Data Center, Baton Rouge, LA 78074-4490 USA.

ASSESSMENT OF INVASIVENESS AND ECOLOGICAL IMPACT IN NON-NATIVE PLANTS OF TEXAS

Guy L. Nesom
2925 Hartwood Drive
Fort Worth, Texas 76109, U.S.A.
guynesom@sbcglobal.net

ABSTRACT

An documented account of 812 non-native species reported to grow outside of cultivation in Texas has been developed. About 300 of these have been reported since the 1970 publication of the *Manual of the Vascular Plants of Texas*, and each of the latter taxa has been documented by at least a literature reference. A "Fundamental Invasiveness Index" provides a framework for assessment and ranking of each of the non-native species according to their invasiveness and ecological impact. The Index is based on knowledge of the species from field, herbarium, and literature, according to the following criteria.

F1: Invasive in both disturbed and natural habitats, negatively affecting native species or natural biodiversity by altering native vegetation and habitats or by outcompeting or hybridizing with native species; or, invasive into agricultural habitats and causing significant economic damage; including woody, herbaceous, and aquatic species.

F2: Abundant in number and widespread, commonly invasive in disturbed habitats, much less commonly in natural habitats; subdivided into woody, herbaceous, and aquatic species.

F3: Relatively few in number, known from relatively few localities, usually in disturbed habitats; subdivided into woody and herbaceous species.

F4: Status unknown.

Numbers of species per category are **F1-Woody, Herbaceous, and Aquatic** (51), **F2-Woody** (13), **F2-Herbaceous** (228), **F2-Aquatic** (16), **F3-Woody** (76), **F3-Herbaceous** (348), and **F4** (80). A Watch List includes 52 woody, herbaceous, and aquatic species most likely to warrant F1 ranking.

RESUMEN

Se realiza un informe documentado de 812 especies no nativas que crecen fuera de cultivo en Texas. Unas 300 de ellas se han citado desde la publicación en 1970 del *Manual of the Vascular Plants of Texas*, y cada uno de estos últimos taxa se ha documentado con al menos una referencia bibliográfica. Un "Fundamental Invasiveness Index" ofrece un marco para la evaluación y ordenación de cada una de las especies no nativas de acuerdo a su potencial invasor e impacto ecológico. El índice está basado en el conocimiento de las especies en el campo, herbario, y bibliografía, de acuerdo a los siguientes criterios.

F1: Invasiva tanto en hábitats modificados y naturales, que afecta negativamente a especies nativas o a la biodiversidad natural por alterar la vegetación nativa y hábitats o por competir o hibridar con especies nativas; o, invasoras en hábitats agrícolas causando daños económicos importantes; incluyendo especies leñosas, herbáceas, y acuáticas.

F2: Abundantes en número y extendidas, generalmente invasivas en hábitats alterados, mucho menos en hábitats naturales; subdivididas en especies leñosas, herbáceas, y acuáticas.

F3: Relativamente pocas en número, conocidas de relativamente pocas localidades, usualmente en hábitats alterados; subdivididas en especies leñosas y herbáceas.

F4: Estatus desconocido.

Los números de especies por categoría son **F1-leñosas, herbáceas, y acuáticas** (51), **F2-leñosas** (13), **F2-herbáceas** (228), **F2-acuáticas** (16), **F3-leñosas** (76), **F3-herbáceas** (348), y **F4** (80). Una lista visual incluye 52 especies leñosas, herbáceas, y acuáticas que probablemente justifican una situación en F1.

About 516 non-native species were known 40 years ago to occur outside of cultivation in Texas (as counted from Correll & Johnston 1970)—about 11 percent of the total flora of the state at that time. Since that time, about 300 additional introductions to the state have been reported in various publications (summarized in the PLANTS Database: USDA, NRCS 2009; the PLANTS Database has drawn its information from a variety of sources, including major publications on the Texas flora). The present paper provides a summary account of the currently known non-native Texas flora, with documentation for those species included in

J. Bot. Res. Inst. Texas 3(2): 971 – 991. 2009

the account since 1970 and a ranking of invasiveness and ecological impact for each species included. The system presented here is simple enough to allow a quick assessment of a large number of species but still to provide a fundamental overview of each species.

Various lists of invasive species have been developed for Texas, but documentation for these lists is not readily available. The most comprehensive list is presented by TexasInvasives.org (2009), which includes 139 species, with a photo for each and a listing of the family, common name, duration, habit, and information on morphology, biology, and distribution, including links to detailed Texas maps. Two lists have state-wide legal standing: the Noxious Plant List of the Texas Department of Agriculture (TDA 2009) with 29 species and a list of Prohibited Exotic Species from the Texas Parks and Wildlife Department (TPWD 2009) with 19 aquatic species. The list of 13 aquatic species from the North Texas Water Garden Society (NTWGS 2009) appears to be a subset of the TDA list. The City of Austin lists 26 species (some listed simply as the genus) of Invasive Plants to Avoid (Austin City Connection 2009).

The Invaders of Texas (2009) program organizes teams of local citizen scientists who seek out and report occurrences of invasive species. This is a very useful program, both practically and scientifically—as of May 2009, more than 7400 detailed field observations have been reported and are available online. Each field report includes precise locality information (with coordinates automatically mapped), an indication of abundance at the locality, and usually a photo of the plant or populations taken at the site of observation. The target species sought by the Invaders of Texas participants are the 139 on the TexasInvasives.org list (2009). For each species, individual field observations are mapped in aggregate to show their total distribution in the state.

Non-native species in Texas—development of a list and documentation. A preliminary list of non-native species in Texas was developed by the author from the PLANTS Database (USDA, NRCS 2009), using an Advanced Search for Texas taxa introduced to the Lower 48 states. Journals and other literature were reviewed for possible additions, and a number of species have been excluded. Identifications in the Texas list presented here often are not made to infraspecific rank (in contrast to the PLANTS list), because vouchers commonly have not been examined or because the validity of the infraspecific taxonomy is not clear. Only plants that are naturalized have been included (vs. cultivated or persisting from cultivation), though some on the list probably would best be characterized as waifs (Nesom 2000) if follow-up observations were done at sites where they were reported to occur. Whether or not a species is native sometimes may be difficult to judge—generally such instances are discussed in the documentation for the full list (Nesom 2009a).

Documentation for the occurrence of these species in Texas (Nesom 2009a) begins with literature and other records that have been published mostly after 1970, the date of publication of Correll and Johnston's "*Manual of the Vascular Plants of Texas*," which remains the primary floristic resource for the state. In the course of assigning invasiveness rankings, however, the rationale for inclusion of each species on the full list has been examined. For species included in the documentation, at least one full literature reference is provided, with reported Texas counties and other brief notes on the status of the species, as appropriate or as known. Many taxa on the PLANTS list or from elsewhere have been excluded from the Texas flora because of mistaken or faulty documentation (Nesom 2009b for examples from the Asteraceae), and these are specifically noted in the commentaries (Nesom 2009a). A number of species have been reported simply by listing (Johnston 1990; Hatch et al. 1990) or by mapping (Turner et al. 2003); vouchers or other documentation for these are being provided.

Documentation for the full list of non-native taxa is an essential and critical part of both this process and this report. Because the information is complex and completion and supplementation are ongoing, it remains as an online resource (Nesom 2009a). Addition of voucher information and other documentation for species first reported in lists by Johnston (1990) and Hatch et al. (1990) and elsewhere will be a significant advance.

Systems for assessment and ranking of invasiveness.

In developing a protocol for evaluating Texas non-native species for invasiveness and ecological impact, a representative set of other systems toward the same end has been considered and studied.

* Alien Plants Ranking System (Ver. 5.1) (APRS Implementation Team 2000)
* Ranking Invasive Exotic Plant Species in Virginia (Heffernan et al. 2001)
* Criteria for Categorizing Invasive Non-Native Plants that Threaten Wildlands (Warner et al. 2003)
* An Invasive Species Assessment Protocol: Evaluating Non-native Plants for Their Impact on Biodiversity (Morse et al. 2004)
* Invasiveness Ranking System for Non-native Plants of Alaska (Carlson et al. 2008)
* New York State Plant Ranking System for Evaluating Non-Native Plant Species for Invasiveness (DRAFT) (Jordan et al. 2009).

Perhaps the most widely applied (and adapted) of these is Morse et al. (2004), developed by NatureServe, in collaboration with The Nature Conservancy and the U.S. National Park Service. It is a "protocol for assessing and categorizing non-native plants according to their impacts on native biodiversity." NatureServe Explorer now includes an impact rank ("I-rank"—high, medium, low, or insignificant) for many non-native plant species of the USA.

In each of the systems above, assessment and ranking of an individual species invokes a series of detailed questions grouped into a set of topics, usually including some or all of these:

* ecological impact and potential for future impact;
* biological attributes, including dispersal ability and invasiveness potential;
* ecological amplitude;
* geographic extent of invasion; and
* control/management feasibility and cost.

A significant amount of the information required for the ranking criteria is drawn from literature pertinent to the species under consideration. After scoring is complete for the whole set of questions, the species may be ranked numerically by its additive score, or the additive score may translate to a broader category.

The ranking protocol for the Tennessee Invasive Exotic Plant List (Tennessee EPPC 2001) is considerably different from those above. In the Tennessee system, a species is assigned by a committee of biologists to one of the following categories (the number of Tennessee species in each category is indicated):

Rank 1—Severe Threat: Exotic plant species that possess characteristics of invasive species and spread easily into native plant communities and displace native vegetation. (29 species)

Rank 2—Significant Threat: Exotic plant species that possess characteristics of invasive species but are not presently considered to spread as easily into native plant communities as those species listed as Rank 1. (49 species)

Rank 3—Lesser Threat: Exotic plant species that spread in or near disturbed areas; and are not presently considered a threat to native plant communities. (28 species)

Watch List A—Exotic plants that naturalize and may become a problem in the future; includes species that are or could become widespread in Tennessee. At this time more information is needed, and there is no consensus about their status. (24 species)

Watch List B—Exotic plant species that are severe problems in surrounding states but have not been reported in Tennessee. (6 species)

The protocol proposed here for Texas non-native species is very similar to the one developed for Tennessee.

Invasiveness and ecological impact of Texas non-native species.

The system outlined here for use in Texas emphasizes simplicity, allowing assessment of the large number of non-native species (all that are known to occur in the state). Because essential elements of biology and geography are included in the assessments, the system is termed the Fundamental Invasiveness Index. After becoming familiar with the categories of the index and the characteristics of the species under consideration, the species is assigned to one of the categories. The first category (F1) applies to species that have invasive biological characteristics as well as a strong and adverse impact on natural systems and biodiversity (or an adverse economic impact). The other two main categories (F2, F3) include species that are less significant in ecological or economic impact, with the division between species of F2 and F3 made on the basis of their geographic distribution, abundance, and potential for spread. Within F2 and within F3, slightly different characterizations are given for woody and herbaceous species, as the two growth forms are generally distinct in biology.

The biology of aquatic species is distinct from terrestrial ones, in part because of their potential for extremely rapid dispersal in local aquatic systems. Emergents that grow in open water—sometimes persisting in mud flats or in periodically wet habitats (i.e., *Alternanthera*, *Ludwigia*, *Nasturtium*)—are included as aquatics. Each species has the potential to cause major ecosystem damage, and many of them already are recognized as noxious over wide regions; others are ecologically damaging at least locally in the lake or stream where they occur. Somewhat arbitrarily, aquatic species are recognized here in the category of maxinum negative effect if they occur in 10 or more counties (as recorded by herbarium voucher specimens, expert sightings or photos, or other reliable documentation). *Hydrilla verticillata* is vouchered by specimens at TEX for only about six Texas counties but clearly occurs more widely (as do some of the other species). Otherwise, aquatic species known to occur in 9 or fewer counties all are placed in the same category.

A ranking system such as that from NatureServe provides assessments based on array of explicit and detailed criteria. For Texas and its large number of non-native species, contemplation of such an intricate system and the massive amount of time required for its completion perhaps has inhibited even the beginning of one. The system here, however, appears to provide a realistic overview of the situation in Texas, even though many assessments remain to be clarified for species currently included. Further, the current account at least provides a basis from which more detailed assessments may be developed.

For accurate evaluation of an individual species, knowledge is required of the following.

* **Nativity.** Is the species native or non-native?

* **Approximate date of introduction in Texas (e.g., pre-1970, 1970s, 1980s, 1990s).** Documentation in the current system does not provide specific information for species introduced before 1970 (those included in Correll & Johnston's Manual of the Vascular Plants of Texas), but for species recorded since that time, dates are evident, as much as possible, in a review posted and periodically updated on the internet (Nesom 2009a).

* **Current geographic distribution.** Based on distribution maps in Turner et al. (2003), distribution maps generated by data from Invaders of Texas (2009), records from herbaria (primarily those in Texas), and literature.

* **Ecological/reproductive behavior in Texas and in other regions.** Based on field experience of the author and others, published literature, information from herbarium collections.

* **Basic habitat and growth form (aquatic or terrestrial, herbaceous or woody).** Based on field experience, published literature, information from herbarium collections.

FUNDAMENTAL INVASIVENESS INDEX

F1—Invasive in both disturbed and natural habitats. Negatively affecting native species or natural biodiversity by altering native vegetation and habitats or by outcompeting or hybridizing with native species; or, invasive into agricultural habitats and causing significant economic damage. Aquatic species known to occur in 10 or more counties. Woody, herbaceous, and aquatic species. Examples: *Arundo donax*, *Bothriochloa ischaemum* var. *songarica*, *Centaurea melitensis*, *Eichhornia crassipes*, *Ligustrum sinense*, *Lonicera japonica*, *Lygodium japonicum*, *Nandina domestica*, *Salvinia molesta*, *Sorghum halepense*, *Triadica (Sapium) sebifera*, *Ulmus pumila*.

F2—Abundant in number and widespread, commonly invasive in disturbed habitats, much less commonly in natural habitats (Table 1).

F2-Woody—Trees, shrubs, subshrubs, and woody vines. Abundant in number and widespread, commonly invasive in disturbed habitats such as roadsides, fencerows, woods edges, and others, sometimes potentially or incipiently damaging in natural habitats (as F1). Examples: *Albizia julibrissin*, *Morus alba*, *Nicotiana glauca*, *Poncirus trifoliata*, *Pyrus calleryana*, *Vitex agnus-castus*.

F2-Herbaceous—Annual and perennial herbs and grasses. Known invasive and/or clearly expanding in geographic range, primarily in lawns, roadsides, and other open, disturbed habitats, sometimes in croplands, widespread and usually abundant but often produc-

Table 1. Numbers of non-native species in Texas ranked as F1, F2, F3, and F4. The total is 812 species.

	Woody	Herbaceous	Aquatic	TOTAL
F1	17	25	9	51
F2	13	228	16	258
F3	76	348		424
F4	0	80		80

ing relatively little biomass. Not significantly affecting native species or natural biodiversity or otherwise strongly altering native vegetation and habitats. Examples: *Avena sativa, Bellardia trixago, Coronilla varia, Daucus carota, Duchesnia indica, Erodium cicutarium, Galium aparine, Gamochaeta coarctata, Hypochaeris microcephala, Lamium amplexicaule, Medicago lupulina, Stachys floridana, Stellaria media, Taraxacum officinale, Torilis nodosa, Trifolium repens, Veronica arvensis, Vicia sativa.*

F2-Aquatic—Aquatic species known to occur in 1 to 9 counties.

F3—Relatively few in number, known from relatively few localities, usually in disturbed habitats.

F3-Woody—Trees, shrubs, subshrubs, and woody vines. Relatively few in number, known from relatively few localities, usually in disturbed habitats, repeatedly introduced or perhaps merely long-persisting at some localities, not showing aggresively invasive tendencies, or perhaps incipiently invasive. Examples: *Ardisia crenata, Buddleja lindleyana, Cinnamomum camphora, Hibiscus syriacus, Koelreuteria elegans, Manihot esculenta, Photinia serratifolia, Pistacia chinensis, Pyracantha koidzumii, Pyrus communis, Rosmarinus officinalis.*

F3-Herbaceous—Annual and perennial herbs and grasses. Occurrence outside of cultivation known from only one or a few populations, usually in disturbed habitats. Apparently showing little or no increase of abundance or geographic range since the initial report. Examples: *Cichorium intybus, Gomphrena globosa, Phyllanthus fraternus, Plantago coronopus. Or in some species, sporadically appearing from repeated introductions and not reproducing. Examples: Citrullus lanatus, Consolida orientalis, Ipomoea batatas, Luffa aegyptiaca, Narcissus pseudonarcissus, Tagetes erecta.*

F4—Status unknown.

Watch list: terrestrial non-native species in Texas potentially ranked as F1.

Many of the non-native species in Texas occur only in small areas. Among these are a significant number that have been relatively recently recorded for the state and that are known to be both highly invasive and ecologically destructive in other regions of the United States. These features characterize the species included on the Texas "Watch List" (Appendix 5). These species may be expected to spread in Texas and become ecologically problematic. Some of the woody species, like *Cinnamomum camphora*, *Photinia serratifolia*, *Pistacia chinensis*, and *Vitex agnus-castus* are widely planted and seeds often are nearly ubiquitous around urban areas—each of these species already appears to be spreading into natural habitats. In contrast, species such as *Albizia julibrissin* and *Morus alba* are invasive and occur in large numbers but appear to be more restricted to disturbed habitats or to edges of woods.

An interesting point regarding pantropical maritime species potentially or incipiently invasive in Texas has been raised by Tom Patterson (*South Texas College*, Rio Grande City). "How to classify these new arrivals? For the most part, they have not escaped from cultivation. But they potentially are a threat and I believe they need their own category. After tropical storms South Padre Island receives sea beans, red mangrove fruits, and coconuts. Some of these propagules in the past have produced plants and have been infrequently documented by collections, only later to succumb to a severe freeze. With global warming more of these pantropical maritime species will persist and become naturally adventive to Texas." In this category Patterson includes *Caesalpina bonduc*, *Canavalia rosea*, *Cassytha filiformis*, *Conocarpus erectus*, *Laguncularia racemosa*, *Rhizophora mangle*, and *Scaveola plumieri*. These are added as a special category in the Watch List (Appendix 5).

Roadside flora.

The emphasis here on ecological impact to natural habitats is especially significant in Texas, where such a relatively small portion of the land is unaltered and it is critical to protect remaining natural areas. Following that thought, however, roadsides in Texas are exceptionally significant since they comprise a significant portion of public land in the state and in some places are important in harboring elements of the native flora.

"It's hard to know what to do with roadsides. They're not entirely natural, and sometimes the weediness stops at the fence. Don't you wish you had a time machine and could go back 1000 years (or 100) and see Texas without all of the exotics? I wonder what spring would look like without all the non-native mustards, mints, beans, grasses, etc. What might we have had that is no longer here at all? All that vetch and clover and henbit and shepherd's purse had to replace *something*" (Monique Reed, pers. comm.).

APPENDIX 1

All non-native species known to occur in Texas, with "Fundamental Invasiveness Index" rankings. Species on the "**WATCH** List" (Appendix 4) are indicated.

ACANTHACEAE

Hygrophila polysperma (Roxb.) T. Anders.—**F2-Woody**
Nomaphila stricta (Vahl) Nees—**F2-Woody**
Ruellia caerulea Morong—**F3-Herbaceous**
  SYN= Ruellia brittoniana Leonard
Thunbergia alata Bojer ex Sims—**F3-Herbaceous**

ALOACEAE

Aloe vera (L.) Burm. f.—**F3-Herbaceous**

AMARANTHACEAE

Achyranthes aspera L.—**F3-Herbaceous**
Alternanthera caracasana Kunth—**F2-Herbaceous**
Alternanthera philoxeroides (Mart.) Griseb.—**F1-Woody**
Alternanthera pungens Kunth—**F3-Herbaceous**
Alternanthera tenella Colla—**F3-Herbaceous**
  SYN= Alternanthera bettzichiana (Regel.) Standl.
Amaranthus blitum L.—**F2-Herbaceous**
  SYN= Amaranthus viridus auct. non L.
Amaranthus cruentus L.—**F3-Herbaceous**
  SYN= Amaranthus hybridus var. cruentus (L.) Moq.
Amaranthus hypochondriacus L.—**F3-Herbaceous**
Amaranthus sessilis (L.) DC.—**F4-Herbaceous**
Celosia argentea L.—**F3-Herbaceous**
Gomphrena globosa L.—**F2-Herbaceous**

AMARYLLIDACEAE

Amaryllis belladonna L.—**F3-Herbaceous**
Habranthus tubispathus (L'Her.) Traub—**F3-Herbaceous**
  SYN= Habranthus texanus (-Herbaceousert) Steud.
Narcissus jonquilla L.—**F3-Herbaceous**
Narcissus pseudonarcissus L.—**F3-Herbaceous**
Narcissus tazetta L.—**F3-Herbaceous**

ANACARDIACEAE

Pistacia chinensis Bunge—**F3-Woody WATCH**
Schinus longifolius (Lindl.) Speg.—**F3-Woody**
Schinus molle L.—**F3-Woody WATCH**
Schinus terebinthifolius Raddi—**F3-Woody WATCH**

APIACEAE

Ammi majus L.—**F2-Herbaceous**
Ammi visnaga (L.) Lam.—**F3-Herbaceous**
Anethum graveolens L.—**F3-Herbaceous**
Bupleurum lancifolium Hornem.—**F3-Herbaceous**
Bupleurum rotundifolium L.—**F2-Herbaceous**
Conium maculatum L.—**F2-Herbaceous**
Coriandrum sativum L.—**F3-Herbaceous**
Cuminum cyminum L.—**F3-Herbaceous**
Cyclospermum leptophyllum (Pers.) Sprague ex Britt. & Wilson—**F2-Herbaceous**
  SYN= Apium leptophyllum (Pers.) F. Muell. ex Benth.
Daucus carota L.—**F2-Herbaceous**
Foeniculum vulgare P. Mill.—**F3-Herbaceous**
Hydrocotyle sibthorpioides Lam.—**F3-Herbaceous**
Pastinaca sativa L.—**F3-Herbaceous**
Petroselinum crispum (P. Mill.) Nyman ex A.W. Hill—**F3-Herbaceous**
  SYN= Apium petroselinum L.
Scandix pecten-veneris L.—**F3-Herbaceous**
Torilis arvensis (Huds.) Link—**F2-Herbaceous WATCH**
Torilis nodosa (L.) Gaertn.—**F2-Herbaceous**

APOCYNACEAE

Catharanthus roseus (L.) G. Don—**F3-Woody**
  SYN= Vinca rosea L.
Nerium oleander L.—**F3-Woody**
Vinca major L.—**F2-Herbaceous**
Vinca minor L.—**F4-Herbaceous**

ARACEAE

Colocasia esculenta (L.) Schott—**F1-Woody**
  SYN= Colocasia antiquorum Schott
Cryptocoryne beckettii Thwaites ex Trimen—**F2-Woody**
Pistia stratiodes L.—**F1-Woody**
Xanthosoma sagittifolium (L.) Schott—**F2-Woody**

ARALIACEAE

Hedera helix L.—**F2-Herbaceous**

ASCLEPIADACEAE

Asclepias curassavica L.—**F3-Herbaceous**
Cryptostegia grandiflora (Roxb. ex R. Br.) R. Br.—**F3-Herbaceous WATCH**
Periploca graeca L.—**F3-Herbaceous**

ASTERACEAE Aster Family

Acanthospermum australe (Loefl.) Kuntze—**F4-Herbaceous**
Acroptilon repens (L.) DC.—**F4-Herbaceous**
  SYN= Centaurea repens L.
Anthemis cotula L.—**F2-Herbaceous**
Bidens pilosa L.—**F3-Herbaceous**
  SYN= Bidens odorata Cav.
Carduus acanthoides L.—**F3-Herbaceous**
Carduus nutans subsp. **macrocephalus** (Desf.) Nyman—**F1-Herbaceous**

SYN= Carduus macrocephalus Desf.
SYN= Carduus nutans var. macrocephalus (Desf.) Boivin
Carduus pycnocephalus L.—**F2-Herbaceous WATCH**
Carthamus lanatus L.—**F3-Herbaceous**
Carthamus tinctorius L.—**F3-Herbaceous**
Centaurea cyanus L.—**F2-Herbaceous**
Centaurea melitensis L.—**F1-Herbaceous**
Centaurea solstitialis L.—**F4-Herbaceous**
Cichorium intybus L.—**F2-Herbaceous**
Cirsium vulgare (Savi) Ten.—**F2-Herbaceous WATCH**
SYN= Carduus lanceolatus L.
Cnicus benedictus L.—**F4-Herbaceous**
SYN= Centaurea benedicta (L.) L.
Conyza bonariensis (L.) Cronq.—**F2-Herbaceous**
SYN= Erigeron bonariensis L.
Cosmos bipinnatus Cav.—**F3-Herbaceous**
Cosmos sulphureus Cav.—**F3-Herbaceous**
Cotula australis (Sieber) Hook. f.—**F3-Herbaceous**
Crepis capillaris (L.) Wallr.—**F4-Herbaceous**
Crepis pulchra L.—**F3-Herbaceous**
Crepis setosa Haller f.—**F4-Herbaceous**
Crepis zacintha (L.) Babcock—**F4-Herbaceous**
Emilia fosbergii D.H. Nicols.—**F4-Herbaceous**
Facelis retusa (Lam.) Schultz-Bip.—**F2-Herbaceous**
Galinsoga parviflora Cav.—**F2-Herbaceous**
SYN= Galinsoga parviflora var. semicalva Gray
Gamochaeta antillana (Urb.) Anderb.—**F2-Herbaceous**
Gamochaeta calviceps (Fern.) Cabrera—**F2-Herbaceous**
Gamochaeta coarctata (Willd.) Kerg.—**F2-Herbaceous**
Gamochaeta pensylvanica (Willd.) Cabrera—**F2-Herbaceous**
Hedypnois cretica (L.) Dum.-Cours.—**F2-Herbaceous**
Hypochaeris brasiliensis var. **tweediei** (Hook. & Arn.) Baker—**F2-Herbaceous**
SYN= Hypochaeris tweediei Hook. & Arn.
Hypochaeris glabra L.—**F2-Herbaceous**
Hypochaeris microcephala var. **albiflora** (Kuntze) Cabrera—**F2-Herbaceous**
Hypochaeris radicata L.—**F2-Herbaceous**
Lactuca saligna L.—**F3-Herbaceous**
Lactuca serriola L.—**F2-Herbaceous**
SYN= Lactuca scariola L.
Lapsana communis L.—**F3-Herbaceous**
Leontodon hispidus L.—**F3-Herbaceous**
Leontodon taraxacoides (Vill.) Mérat—**F4-Herbaceous**
Leucanthemum vulgare Lam.—**F2-Herbaceous**
SYN= Chrysanthemum leucanthemum L.
Matricaria recutita L. Wild Chamomile—**F4-Herbaceous**
SYN= Chamomilla recutita (L.) Rauschert
SYN= Matricaria chamomilla var. coronata (J. Gay) Coss. & Germ.
SYN= Matricaria suaveolens L.
Onopordum acanthium L.—**F2-Herbaceous**
Pseudognaphalium luteoalbum (L.) Hilliard & Burtt—**F2-Herbaceous**
Sanvitalia angustifolia A. Gray—**F3-Herbaceous**
Scorzonera laciniata L.—**F2-Herbaceous**
Senecio vulgaris L.—**F2-Herbaceous**
Silybum marianum (L.) Gaertn.—**F3-Herbaceous**
Solivia anthemiifolia (Juss.)—**F2-Herbaceous**
SYN= Soliva mutisii Kunth
Soliva sessilis Ruiz & Pavón—**F2-Herbaceous**
SYN= Soliva pterosperma (Juss.) Less.
Soliva stolonifera (Brot.) Sweet—**F2-Herbaceous**
SYN= Gymnostyles stolonifera (Brot.) Tutin—
SYN= Gymnostyles nasturtiifolia Juss.
Sonchus asper (L.) Hill—**F2-Herbaceous**
Sonchus oleraceus L.—**F2-Herbaceous**
Sphagneticola trilobata (L.) Pruski—**F3-Herbaceous**
SYN= Wedelia trilobata L.
Symphyotrichum squamatum (Spreng.) Nesom—**F4-Herbaceous**
SYN = Aster subulatus var. sandwicensis A. Gray
Tagetes erecta L.—**F4-Herbaceous**
Taraxacum laevigatum (Willd.) DC.—**F2-Herbaceous**
SYN= Taraxacum erythrospermum Andrz. ex Bess.
Taraxacum officinale L. subsp. **officinale**—**F2-Herbaceous**
Tragopogon dubius Scop.—**F2-Herbaceous**
Tragopogon porrifolius L.—**F2-Herbaceous**
Tridax procumbens L.—**F3-Herbaceous**
Xanthium spinosum L.—**F2-Herbaceous**
SYN= Xanthium spinosum var. inerme Bel.
Youngia japonica (L.) DC.—**F2-Herbaceous**
Zinnia violacea Cav.—**F3-Herbaceous**

BASELLACEAE
Anredera cordifolia (Ten.) Steenis—**F3-Herbaceous**
SYN= Boussingaultia gracilis Miers

BERBERIDACEAE
Nandina domestica Thunb.—**F1-Woody**

BIGNONIACEAE
Macfadyena unguis-cati (L.) A.H. Gentry—**F3-Woody WATCH**
Paulownia tomentosa (Thunb.) Sieb. & Zucc. ex Steud.—**F3-Woody**

BORAGINACEAE
Anchusa azurea P. Mill.—**F3-Herbaceous**
SYN= Anchusa italica Retz.
Buglossoides arvensis (L.) I.M. Johnston—**F2-Herbaceous**
SYN= Lithospermum arvense L.
Cynoglossum zeylanicum (Vahl) Thunb. ex Lehm.—**F3-Herbaceous**
Echium vulgare L.—**F3-Herbaceous**
Heliotropium amplexicaule Vahl—**F2-Herbaceous**
Heliotropium europaeum L.—**F3-Herbaceous**
Heliotropium indicum L.—**F2-Herbaceous**
Lappula squarrosa (Retz.) Dumort.—**F4-Herbaceous**

BRASSICACEAE Mustard Family
Arabidopsis thaliana (L.) Heynh.—**F2-Herbaceous**
Brassica juncea (L.) Czern.—**F3-Herbaceous**
Brassica nigra (L.) W.D.J. Koch—**F3-Herbaceous**
Brassica oleracea L.—**F3-Herbaceous**
Brassica rapa L.—**F2-Herbaceous**
SYN= Brassica campestris var. rapa (L.) Hartman

SYN= Brassica rapa var. campestris (L.) W.D.J. Koch
Brassica tournefortii Gouan—**F3-Herbaceous**
Cakile maritima Scop.—**F4-Herbaceous**
Camelina microcarpa DC.—**F2-Herbaceous**
SYN= Camelina sativa subsp. microcarpa (DC.) E. Schmid
Camelina rumelica Velen.— **F3-Herbaceous**
Capsella bursa-pastoris (L.) Medik.—**F2-Herbaceous**
Cardamine debilis D. Don—**F2-Herbaceous**
Cardamine hirsuta L.—**F2-Herbaceous**
Cardaria draba (L.) Desv.—**F3-Herbaceous**
Chorispora tenella (Pallas) DC.—**F2-Herbaceous**
Conringia orientalis (L.) Dumort.—**F2-Herbaceous**
Coronopus didymus (L.) Sm.—**F2-Herbaceous**
Descurainia sophia (L.) Webb ex Prantl—**F2-Herbaceous**
Diplotaxis muralis (L.) DC.—**F2-Herbaceous**
Diplotaxis tenuifolia (L.) DC.—**F3-Herbaceous**
Eruca vesicaria subsp. **sativa** (P. Mill.) Thellung—**F2-Herbaceous**
SYN= Brassica eruca L.
SYN= Eruca sativa P. Mill.
SYN= Raphanus eruca (L.) Crantz
Erucastrum gallicum (Willd.) O.E. Schulz—**F2-Herbaceous**
Erysimum repandum L.—**F2-Herbaceous**
Lepidium campestre (L.) R. Br.—**F3-Herbaceous**
Lepidium latifolium L.—**F3-Herbaceous**
Lepidium ruderale L.—**F3-Herbaceous**
Lobularia maritima (L.) Desv.—**F3-Herbaceous**
SYN= Alyssum maritimum (L.) Lam.
Matthiola incana (L.) Ait. f.—**F3-Herbaceous**
Matthiola longipetala (Vent.) DC.—**F3-Herbaceous**
SYN= Matthiola longipetala subsp. bicornis (Sibthorp & Sm.) P.W. Ball
Myagrum perfoliatum L.—**F3-Herbaceous**
Nasturtium officinale W.T. Ait.—**F1-Woody**
SYN= Rorippa nasturtium-aquaticum (L.) Hayek
Raphanus rapistrum L.—**F3-Herbaceous**
Raphanus sativus L.—**F3-Herbaceous**
SYN= Raphanus raphanistrum var. sativus (L.) G. Beck
Rapistrum rugosum (L.) All.—**F1-Herbaceous**
Sinapis alba L.—**F4-Herbaceous**
Sinapis arvensis L.—**F2-Herbaceous**
SYN= Brassica kaber (DC.) L.C. Wheeler
Sisymbrium altissimum L.—**F2-Herbaceous**
Sisymbrium irio L.—**F2-Herbaceous**
Sisymbrium officinale (L.) Scop.—**F2-Herbaceous**
Sisymbrium orientale L.—**F3-Herbaceous**
SYN= Brassica kaber var. orientalis (L.) Scoggan
Sisymbrium polyceratium L.—**F3-Herbaceous**
Thlaspi arvense L.—**F2-Herbaceous**

CACTACEAE

Opuntia ficus-indica (L.) P. Mill.—**F3-Woody**
SYN= Opuntia compressa J.F. Macbr.
Pereskia aculeata P. Mill.—**F3-Woody**

CAMPANULACEAE

Campanula rapunculoides L.—**F3-Herbaceous**
Wahlenbergia marginata (Thunb.) A. DC.—**F3-Herbaceous**

CANNABACEAE

Cannabis sativa L. var. sativa—**F3-Woody**

CANNACEAE

Canna ×generalis Bailey [glauca × indica]—**F3-Herbaceous**
SYN= Canna ×orchiodes Bailey
Canna indica L.—**F3-Herbaceous**
SYN= Canna coccinea P. Mill.

CAPPARACEAE

Cleome gynandra L.—**F3-Herbaceous**
SYN= Cleome pentaphylla L.
Cleome hassleriana Chod.—**F4-Herbaceous**
SYN= Cleome pungens auct. non Willd.
SYN= Cleome spinosa auct. non Jacq.

CAPRIFOLIACEAE

Lonicera fragrantissima Lind. & Paxton—**F3-Woody**
Lonicera japonica Thunb.—**F1-Woody**
Lonicera maackii (Rupr.) Herder—**F3-Woody WATCH**

CARYOPHYLLACEAE

Agrostemma githago L.—**F3-Herbaceous**
Arenaria serpyllifolia L.—**F2-Herbaceous**
Cerastium fontanum Baumg.—**F2-Herbaceous**
SYN= Cerastium holosteoides auct. non Fries
SYN= Cerastium holosteoides var. vulgare (Hartman) Hyl.
Cerastium glomeratum Thuill.—**F2-Herbaceous**
SYN= Cerastium viscosum auct. non L.
Cerastium pumilum W. Curtis—**F2-Herbaceous**
Dianthus armeria L.—**F3-Herbaceous—**
Dianthus barbatus L.—**F4-Herbaceous**
Gypsophila elegans M. Bieb—**F3-Herbaceous**
Holosteum umbellatum L.—**F2-Herbaceous**
Petrorhagia dubia (Raf.) López & Romo—**F2-Herbaceous**
SYN= Petrorhagia velutina (Guss.) P.W. Ball & Heywood
Polycarpon tetraphyllum (L.) L.—**F2-Herbaceous**
Sagina procumbens L.—**F4-Herbaceous**
Saponaria officinalis L.—**F3-Herbaceous**
Silene conoidea L.—**F3-Herbaceous**
Silene dichotoma Ehrh.—**F4-Herbaceous**
Silene gallica L.—**F2-Herbaceous**
Spergula arvensis L.—**F3-Herbaceous**
Spergularia echinosperma (Celak.) Aschers. & Graebn.—**F3-Herbaceous—**
Spergularia platensis (Camb.) Fenzl—**F3-Herbaceous**
Stellaria media (L.) Vill.—**F2-Herbaceous**
Stellaria pallida (Dumort.) Crépin—**F2-Herbaceous**
SYN= Stellaria media subsp. pallida (Dumort.) Aschers. & Graebn.
Stellaria parva Pedersen—**F3-Herbaceous**
Vaccaria hispanica (P. Mill.) Rauschert—**F2-Herbaceous**
Vaccaria pyramidata Medic.—**F2-Herbaceous**

CASUARINACEAE

Casuarina equisetifolia L.—**F3-Woody WATCH**

CELASTRACEAE

Euonymus fortunei (Turcz.) Hand.-Mazz.—**F3-Herbaceous**

CHENOPODIACEAE

Atriplex holocarpa F. Muell.—**F3-Woody**

Atriplex rosea L.—**F3-Herbaceous**
Atriplex semibaccata R. Br.—**F1-Herbaceous**
Bassia hyssopifolia (Pallas) Kuntz—**F3-Herbaceous**
  SYN= Kochia hyssopifolia (Pallas) Schrad.
Bassia scoparia (L.) A.J. Scott—**F1-Herbaceous**
  SYN= Kochia scoparia (L.) Schrad.
Beta vulgaris L.—**F3-Herbaceous**
  SYN= Beta vulgaris subsp. maritima (L.) Arcang.
Chenopodium album L.—**F2-Herbaceous**
Chenopodium ambrosioides L.—**F2-Herbaceous**
Chenopodium botrys L.—**F3-Herbaceous**
Chenopodium glaucum L.—**F3-Herbaceous**
Chenopodium murale L.—**F2-Herbaceous**
Chenopodium opulifolium Schrad. ex Koch & Ziz—**F4-Herbaceous**
  SYN= Chenopodium album var. viride (L.) Moq.
  SYN= Chenopodium viride L.
Chenopodium pumilio R. Br.—**F3-Herbaceous**
  SYN= Chenopodium carinatum auct. non R. Br.
Chenopodium vulvaria L.—**F4-Herbaceous**
Salsola collina Pallas—**F4-Herbaceous**
Salsola kali L. subsp. **pontica** (Pallas) Mosyakin—**F1-Herbaceous**
  SYN= Salsola kali var. pontica Pallas
  SYN= Salsola pontica (Pallas) A. Degen
Salsola tragus L.—**F1-Herbaceous**
  SYN= Salsola iberica (Sennen & Pau) Botsch. ex Czerepanov
  SYN= Salsola kali subsp. tragus (L.) Celak.
  SYN= Salsola pestifer A. Nels.
Spinacia oleracea L.—**F3-Herbaceous**

CLUSIACEAE
Hypericum perforatum L.—**F2-Woody WATCH**

COMBRETACEAE
Conocarpus erectus L.—**F3-Woody**
Laguncularia racemosa (L.) Gaertn.—**F3-Woody**

COMMELINACEAE
Commelina communis L.—**F2-Herbaceous**
Gibasis pellucida (Mart. & Gal.) D.R. Hunt—**F2-Herbaceous**
Murdannia nudiflora (L.) Brenan—**F2-Herbaceous**
  SYN= Aneilema nudicaule (Burm. f.) G. Don
  SYN= Aneilema nudiflorum (L.) Sweet

CONVOLVULACEAE
Convolvulus arvensis L.—**F2-Herbaceous**
Ipomoea alba L.—**F3-Herbaceous**
Ipomoea batatas (L.) Lam.—**F4-Herbaceous**
Ipomoea cairica (L.) Sweet—**F3-Herbaceous**
Ipomoea capillacea (Kunth) G. Don—**F3-Herbaceous**
Ipomoea carnea Jacq.—**F2-Herbaceous**
  SYN= Ipomoea crassicaulis (Benth.) B.L. Robins.
  SYN= Ipomoea fistulosa Mart. ex Choisy
Ipomoea fistulosa Mart.—**F4-Herbaceous**
Ipomoea hederifolia L.—**F4-Herbaceous**
  SYN= Ipomoea coccinea var. hederifolia (L.) Gray
Ipomoea indica (Burm. f.) Merr.—**F3-Herbaceous**
  SYN= Ipomoea acuminata (Vahl) Roemer & J.A. Schultes
Ipomoea nil (L.) Roth—**F3-Herbaceous**
Ipomoea quamoclit L.—**F3-Herbaceous**
Ipomoea setosa Ker-Gawl.—**F4-Herbaceous**
Ipomoea tricolor Cav.—**F3-Herbaceous**
Ipomoea turbinata Lag.—**F4-Herbaceous**
  SYN= Ipomoea muricata (L.) Jacq.
Ipomoea violacea L.—**F4-Herbaceous**
Ipomoea wrightii Gray—**F4-Herbaceous**
  SYN= Ipomoea heptaphylla (Roxb.) Voigt

CRASSULACEAE
Kalanchoe daigremontana Raym.-Hamet & Perrier—**F3-Herbaceous**
Kalanchoe delagoensis Ecklon & Zeyh.—**F4-Herbaceous**
  SYN= Kalanchoe tubiflora (Harvey) Hamet
  SYN= Kalanchoe verticilllata Ell.
Kalanchoe fedtschenkoi Raym.-Hamet & H. Perrier—**F4-Herbaceous**

CUCURBITACEAE
Citrullus colocynthis (L.) Schrad.—**F4-Herbaceous**
Citrullus lanatus var. **citroides** (Bailey) Mansf.—**F4-Herbaceous**
  SYN= Citrullus vulgaris var. citroides Bailey
Citrullus lanatus (Thunb.) Mansf. var. **lanatus**—**F4-Herbaceous**
  SYN= Citrullus vulgaris Schrad.
Coccinia grandis (L.) Voigt—**F4-Herbaceous**
  SYN= Coccinia cordifolia sensu Correll & Johnston
Cucumis anguria L.—**F3-Herbaceous**
Cucumis dipsaceus C.G. Ehrenb. ex Spach—**F3-Herbaceous**
Cucumis melo L.—**F2-Herbaceous**
Cucumis melo var. **dudain** Naud.—**F4-Herbaceous**
Lagenaria siceraria (Molina) Standl.—**F3-Herbaceous**
Luffa aegyptiaca P. Mill.—**F3-Herbaceous**
  SYN= Luffa cylindrica (L.) M. Roemer
Momordica balsamina L.—**F4-Herbaceous**
Momordica charantia L.—**F4-Herbaceous**

CUSCUTACEAE
Cuscuta japonica Choisy—**F3-Herbaceous**
Cuscuta suaveolens Ser.—**F3-Herbaceous**

CYPERACEAE
Bulbostylis barbata (Rottb.) C.B. Clarke—**F3-Herbaceous**
Cyperus difformis L.—**F2-Herbaceous**
Cyperus entrerianus Bockeler—**F1-Herbaceous**
Cyperus eragrostis Lam.—**F3-Herbaceous**
  SYN= Cyperus vegetus Willd.
Cyperus involucratus Rottb.—**F2-Herbaceous**
Cyperus iria L.—**F2-Herbaceous**
Cyperus phaeolepis Cherm.—**F4-Herbaceous**
Cyperus prolixus Kunth—**F3-Herbaceous**
Cyperus rotundus L.—**F2-Herbaceous**
Rhynchospora debilis Gale—**F3-Herbaceous**

DIOSCOREACEAE
Dioscorea bulbifera L.—**F4-Herbaceous**

DIPSACACEAE
Scabiosa atropurpurea L.—**F2-Herbaceous**
Dipsacus fullonum L.—**F3-Herbaceous**

DRYOPTERIDACEAE
Cyrtomium falcatum (L. f.) K. Presl—**F3-Herbaceous**
SYN= Polystichum falcatum (L. f.) Diels

ELAEAGNACEAE
Elaeagnus angustifolia L.—**F3-Woody WATCH**
Elaeagnus commutata Rydb.—**F3-Woody**
Elaeagnus pungens Thunb.—**F3-Woody**

EUPHORBIACEAE
Croton argenteus L.—**F2-Herbaceous**
Chamaesyce hirta (L.) Millsp.—**F3-Herbaceous**
Euphorbia cyparissias L.—**F4-Herbaceous**
Euphorbia exigua L.—**F3-Herbaceous**
Euphorbia helioscopia L.—**F3-Herbaceous**
Euphorbia lathyris L.—**F3-Herbaceous**
Manihot esculenta Crantz—**F3-Woody**
Phyllanthus fraternus G.L. Webster—**F3-Herbaceous**
Phyllanthus tenellus Roxb.—**F3-Herbaceous**
Phyllanthus urinaria L.—**F2-Herbaceous**
Ricinus communis L.—**F2-Herbaceous**
Triadica sebifera (L.) Small—**F1-Woody**
SYN= Sapium sebiferum (L.) Roxb.

FABACEAE
Aeschynomene evenia C. Wright—**F3-Herbaceous**
Albizia julibrissin Durazz.—F2-Woody
Albizia lebbeck (L.) Benth.—**F3-Woody**
Alhagi maurorum Medik.—**F3-Herbaceous**
SYN= Alhagi camelorum Fisch.
Alysicarpus vaginalis (L.) DC.—**F3-Herbaceous**
Arachis hypogaea L.—**F3-Herbaceous**
Caesalpinia gilliesii (Hook.) Wallich ex D. Dietr.—**F3-Woody**
SYN= Poinciana gilliesii Wallich ex Hook.
Caesalpinia mexicana Gray—**F3-Woody**
SYN= Poinciana mexicana (Gray) Britt. & Rose
Caesalpinia pulcherrima (L.) Sw.—**F3-Woody**
SYN= Poinciana pulcherrima L.
Clitoria ternatea L.—**F3-Herbaceous**
Coronilla varia L.—**F2-Herbaceous**
Crotalaria retusa L.—**F3-Herbaceous**
Crotalaria spectabilis Roth—**F3-Herbaceous**
SYN= Crotalaria retzii A.S. Hitchc.
Kummerowia stipulacea (Maxim.) Makino—**F3-Herbaceous**
SYN= Lespedeza stipulacea Maxim.
Kummerowia striata (Thunb.) Schindl.—**F2-Herbaceous**
SYN= Lespedeza striata (Thunb.) Hook. & Arn.
Lathyrus aphaca L.—**F3-Herbaceous**
Lathyrus hirsutus L.—**F2-Herbaceous**
Lathyrus latifolius L.—**F3-Herbaceous**
Lespedeza bicolor Turcz.—**F3-Herbaceous**
Lespedeza cuneata (Dum.-Cours.) G. Don—**F2-Herbaceous WATCH**
Leucaena leucocephala (Lam.) de Wit—**F3-Woody WATCH**
Lotus corniculatus L.—**F3-Herbaceous**
Macroptilium gibbosifolium (Ortega) A. Delgado—**F4-Herbaceous**
Medicago arabica (L.) Huds.—**F2-Herbaceous**
Medicago lupulina L.—**F2-Herbaceous**
Medicago minima (L.) L.—**F2-Herbaceous**
Medicago orbicularis (L.) Bartalini—**F2-Herbaceous**
Medicago polymorpha L.—**F2-Herbaceous**
Medicago sativa L.—**F2-Herbaceous**
SYN= Medicago ×varia Martyn
Melilotus albus Medik.—**F1-Herbaceous**
Melilotus indicus (L.) All.—**F1-Herbaceous**
Melilotus officinalis (L.) Lam.—**F1-Herbaceous**
Neptunia plena (L.) Benth.—**F3-Herbaceous**
Oxyrhynchus volubilis Brandeg.—**F4-Herbaceous**
Prosopis laevigata (Humb. & Bonpl. ex Wil—ld.) M.C. Johnston—**F3-Woody**
Pueraria montana var. **lobata** (Willd.) Maesen & Almeida—**F2-Woody WATCH**
SYN= Pueraria lobata (Willd.) Ohwi
Senna corymbosa (Lam.) Irwin & Barneby—**F3-Woody**
SYN= Cassia corymbosa Lam.
Senna occidentalis (L.) Link—**F2-Herbaceous**
SYN= Cassia occidentalis L.
Sesbania emerus (Aubl.) Urb.—**F2-Herbaceous**
Sesbania punicea (Cav.) Benth.—**F3-Herbaceous**
Sesbania sericea (Willd.) Link—**F3-Herbaceous**
Spartium junceum L.—**F3-Woody**
Sphaerophysa salsula (Pallas) DC.—**F3-Herbaceous**
Trifolium arvense L.—**F3-Herbaceous**
Trifolium campestre Schreb.—**F3-Herbaceous**
Trifolium dubium Sibthorp—**F2-Herbaceous**
Trifolium incarnatum L.—**F2-Herbaceous**
Trifolium lappaceum L.—**F3-Herbaceous**
Trifolium polymorphum Poir.—**F2-Herbaceous**
SYN= Trifolium amphianthum Torr. & Gray
Trifolium pratense L.—**F3-Herbaceous**
Trifolium repens L.—**F2-Herbaceous**
Trifolium resupinatum L.—**F2-Herbaceous**
Trifolium subterraneum L.—**F3-Herbaceous**
Trifolium vesiculosum Savi—**F2-Herbaceous**
Vicia grandiflora Scop.—**F3-Herbaceous**
Vicia hirsuta (L.) S.F. Gray—**F3-Herbaceous**
Vicia lathyroides L.—**F3-Herbaceous**
Vicia lutea L.—**F3-Herbaceous**
Vicia sativa subsp. **nigra** (L.) Ehrh.—**F2-Herbaceous**
SYN= Vicia angustifolia L.
SYN= Vicia sativa var. angustifolia (L.) Ser.
SYN= Vicia sativa var. nigra L.
SYN= Vicia sativa var. segetalis (Thuill.) Ser.
Vicia sativa L. subsp. **sativa**—**F3-Herbaceous**
SYN= Vicia sativa var. linearis Lange
Vicia tetrasperma (L.) Schreb.—**F2-Herbaceous**
Vicia villosa Radzhi subsp. **varia** (Host) Corb.—**F3-Herbaceous**
SYN= Vicia dasycarpa Ten.
Vicia villosa Radzhi subsp. **villosa**—**F2-Herbaceous**
Vigna unguiculata (L.) Walp.—**F3-Herbaceous**
SYN= Vigna sinensis (L.) Savi
Wisteria sinensis (Sims) DC.—**F1-Woody**

FUMARIACEAE
Fumaria densiflora DC.—**F3-Herbaceous**

Fumaria officinalis L.—**F3-Herbaceous**
Fumaria parviflora Lam.—**F4-Herbaceous**

GENTIANACEAE

Centaurium pulchellum (Sw.) Druce—**F2-Herbaceous**
Centaurium muhlenbergeii (Griseb.) Piper—**F2-Herbaceous**

GERANIACEAE

Erodium botrys (Cav.) Bertol.—**F3-Herbaceous**
Erodium malacoides (L.) Willd.—**F3-Herbaceous**
Erodium cicutarium (L.) L'Hér. ext Ait.—**F2-Herbaceous**
Geranium dissectum L.—**F2-Herbaceous**

GOODENIACEAE

Scaveola plumieri (L.) Vahl—**F3-Herbaceous**

HALORAGACEAE

Myriophyllum aquaticum (Vell.) Verdc.—**F1-Woody**
SYN= Myriophyllum brasiliense Camb.
SYN= Myriophyllum proserpinacoides Gillies ex Hook. & Arn.
Myriophyllum spicatum L.—**F1-Woody**

HYDROCHARITACEAE

Egeria densa Planch.—**F2-Woody**
SYN= Elodea densa (Planch.) Caspary
Hydrilla verticillata (L. f.) Royle—**F1-Woody**
Ottelia alismoides (L.) Pers.—**F2-Woody**

IRIDACEAE

Belamcanda chinensis (L.) DC.—**F3-Herbaceous**
Crocosmia ×crocosmiiflora (V. Lemoine) N.E. Br.—**F4-Herbaceous**
Iris pallida Lam.—**F4-Herbaceous**
Iris pseudacorus L.—**F3-Herbaceous**
Romulea rosea (L.) Eckl.—**F3-Herbaceous**
Tritonia crocosmifolia Lem.—**F3-Herbaceous**

JUNCACEAE

Juncus capitatus Weigel—**F2-Herbaceous**

LAMIACEAE

Ajuga reptans L.—**F3-Herbaceous**
Glechoma hederacea L.—**F4-Herbaceous**
Hyptis mutabilis (Rich.) Briq.—**F3-Herbaceous**
Lamium amplexicaule L.—**F2-Herbaceous**
Lamium purpureum L.—**F2-Herbaceous**
Leonotis nepetifolia (L.) Ait. f.—**F2-Herbaceous**
Leonurus cardiaca L.—**F3-Herbaceous**
Leonurus sibiricus L.—**F3-Herbaceous**
Marrubium vulgare L.—**F1-Herbaceous**
Mentha arvensis L.—**F3-Herbaceous**
Mentha ×piperita L.—**F3-Herbaceous**
Mentha ×rotundifolia (L.) Huds.—**F3-Herbaceous**
Mentha spicata L.—**F3-Herbaceous**
Mentha suaveolens Ehrh.—**F3-Herbaceous**
Moluccella laevis L.—**F3-Herbaceous**
Nepeta cataria L.—**F3-Herbaceous**
Perilla frutescens (L.) Britton—**F2-Herbaceous WATCH**
Prunella vulgaris L.—**F2-Herbaceous**
Rosmarinus officinalis L.—**F3-Woody**
Salvia hispanica L.—**F4-Herbaceous**
Salvia tiliifolia Vahl—**F3-Herbaceous**
Scutellaria minor Hudson—**F3-Herbaceous**
Scutellaria racemosa Pers.—**F3-Herbaceous**
Sideritis lanata L.—**F3-Herbaceous**
Stachys floridana Shuttlew. ex Benth.—**F2-Herbaceous WATCH**

LAURACEAE

Cinnamomum camphora (L.) J. Presl—**F3-Woody WATCH**

LEMNACEAE

Landoltia punctata (G. Mey.) Les & Crawford—**F2-Woody**
SYN= Spirodela punctata (G. Mey.) C.H. Thompson

LILIACEAE

Allium ampeloprasum L.—**F3-Herbaceous**
Allium porrum L.—**F3-Herbaceous**
Alstroemeria pulchella L.f.—**F3-Herbaceous**
Asparagus officinalis L.—**F3-Herbaceous**
Asphodelus fistulosus L.—**F3-Herbaceous**
Crinum bulbispermum (Burm.f.) Milne-R. & Schweick.—**F3-Herbaceous**
SYN= Crinum longifolium (L.) Thunb.
Hemerocallis fulva (L.) L.—**F3-Herbaceous**
Hemerocallis lilioasphodelus L.—**F3-Herbaceous**
SYN= Hemerocallis flava (L.) L.
Hyacinthus orientalis L.—**F3-Herbaceous**
Lilium longiflorum Thunb.—**F3-Herbaceous**
Muscari comosum (L.) Mill.—**F3-Herbaceous**
Muscari neglectum Guss. ex Ten.—**F3-Herbaceous**
SYN= Muscari racemosum (L.) Lam. & DC.
Ornithogalum umbellatum L.—**F4-Herbaceous**
Tristagma uniflorum (Lindl.) Traub—**F3-Herbaceous**
SYN= Ipheion uniflorum (Lindl.) Raf.
Zephyranthes candida (Lindl.) -Herbaceousert—**F3-Herbaceous**
SYN= Atamosco candida (Lindl.) Small
Zephyranthes grandiflora Lindl.—**F3-Herbaceous**

LIMNOCHARITACEAE

Hydrocleys nymphoides (H. & B. ex Willd.) Buch.—**F2-Woody**

LINACEAE

Linum grandiflorum Desf.—**F3-Herbaceous**
Linum usitatissimum L.—**F3-Herbaceous**

LOGANIACEAE

Buddleja lindleyana Fort.—**F3-Woody**

LYGODIACEAE

Lygodium japonicum (Thunb. ex Murr.) Sw.—**F1-Herbaceous**

LYTHRACEAE

Cuphea carthagenensis (Jacq.) J.F. Macbr.—**F2-Herbaceous**
Cuphea glutinosa Cham. & Schlecht.—**F3-Herbaceous**
Cuphea viscosissima Jacq.—**F3-Herbaceous**
Lagerstroemia indica L.—F2-Woody
Lythrum salicaria L.—**F3-Herbaceous**

MAGNOLIACEAE

Liriodendron tulipifera L.—**F3-Woody**

MALVACEAE
Abutilon theophrasti Medik.—**F3-Herbaceous**
Alcea rosea L.—**F3-Herbaceous**
SYN= Althaea rosea (L.) Cav.
Hibiscus esculentus L.—**F3-Herbaceous**
Hibiscus syriacus L.—**F3-Woody**
Hibiscus trionum L.—**F3-Herbaceous**
Krapovickasia physaloides (Presl) Fryxell—**F3-Herbaceous**
Lavatera trimestris L.—W2
Malva neglecta Wallr.—**F2-Herbaceous**
Malva parviflora L.—**F2-Herbaceous**
Malva rotundifolia L.—**F3-Herbaceous**
SYN?= Malva pusilla Sm.
Malva sylvestris L.—**F3-Herbaceous**
Malvastrum coromandelianum (L.) Garcke—**F2-Herbaceous**
Malvaviscus penduliflorus DC.—**F4-Herbaceous**
SYN= Malvaviscus aboreus var. penduliflorus (DC.) Schery
Pavonia hastata Cav.—**F3-Herbaceous**

MELIACEAE
Melia azedarach L.—**F1-Woody**

MENYANTHACEAE
Nymphoides indica (L.) Kuntze—**F2-Woody**
Nymphoides peltata (Gmel.) Kuntze—**F2-Woody**

MOLLUGINACEAE
Glinus lotoides L.—**F3-Herbaceous**
Mollugo cerviana (L.) Ser.—**F2-Herbaceous**

MORACEAE
Broussonetia papyrifera (L.) L'Hér. ex Vent.—F2-Woody
Fatoua villosa (Thunb.) Nakai—**F2-Herbaceous**
Ficus carica L.—**F3-Woody**
Ficus pumila L.—**F3-Woody**
Morus alba L.—F2-Woody

MYRSINACEAE
Ardisia crenata Sims—**F3-Woody WATCH**

MYRTACEAE
Myrtus communis L.—**F3-Woody**

NYCTAGINACEAE
Bougainvillea glabra Choisy—**F3-Herbaceous**
Mirabilis jalapa L.—**F3-Herbaceous**

OLEACEAE
Jasminum mesnyi Hance—**F3-Woody**
Ligustrum japonicum Thunb.—**F3-Woody**
Ligustrum lucidum Ait. f.—**F1-Woody**
Ligustrum quihoui Carr.—**F1-Woody**
Ligustrum sinense Lour.—**F1-Woody**

ONAGRACEAE
Ludwigia erecta (L.) H. Hara—**F3-Herbaceous**
Ludwigia grandiflora (M. Micheli) Greuter & Burdet subsp. **grandiflora**—**F2-Woody**
SYN= Ludwigia uruguayensis (Camb.) Hara
Ludwigia grandiflora
subsp. hexapetala (Hook. & Arn.) Nesom & Kartesz—**F2-Woody**
SYN= Ludwigia hexapetala (Hook. & Arn.) Zardini et al.
Oenothera cordata J.W. Loudon—**F2-Herbaceous**

ORCHIDACEAE
Zeuxine strateumatica (L.) Schlechter—**F3-Herbaceous**

OROBANCHACEAE
Orobanche minor Sm.—**F3-Herbaceous**
Orobanche ramosa L.—**F1-Herbaceous**

OXALIDACEAE
Oxalis corniculata L.—**F3-Herbaceous**
Oxalis debilis Kunth—**F2-Herbaceous**
SYN= Oxalis corymbosa DC.
Oxalis articulata Savigny—**F2-Herbaceous**
SYN= Oxalis rubra St. Hil.

PAPAVERACEAE
Eschscholzia californica Cham.—**F3-Herbaceous**
Glaucium corniculatum (L.) J.H. Rudolph—**F3-Herbaceous**
Papaver rhoeas L.—**F3-Herbaceous**
Papaver somniferum L.—**F3-Herbaceous**

PARKERIACEAE
Ceratopteris thalictroides (L.) Brongn.—**F2-Woody**

PEDALIACEAE
Sesamum orientale L.—**F4-Herbaceous**
SYN= Sesamum indicum L.

PINACEAE
Pinus elliottii Engelm.—**F3-Woody**

PIPERACEAE
Peperomia pellucida (L.) Kunth—**F3-Herbaceous**

PLANTAGINACEAE
Plantago coronopus L.—**F3-Herbaceous**
Plantago lanceolata L.—**F2-Herbaceous**
Plantago major L.—**F2-Herbaceous**

POACEAE Grass Family
Achnatherum clandestinum (Hack.) Barkworth—**F3-Herbaceous**
SYN= Stipa clandestina Hack.
Aegilops cylindrica Host—**F2-Herbaceous**
SYN= Triticum cylindricum (Host) Ces., Pass., & Gib.
Agropyron cristatum (L.) Gaertn.—**F3-Herbaceous**
SYN= Agropyron subsp. pectinatum (Bieb.) Tzvelev
SYN= Agropyron cristatiforme Sarkar
SYN= Agropyron pectiniforme Roemer & Schultes
SYN= Agropyron desertorum (Fisch. ex Link) J.A. Schultes
Agrostis avenacea J.F. Gmel.—**F3-Herbaceous**
Agrostis stolonifera L.—**F3-Herbaceous**
SYN= Agrostis alba auct. non L.
SYN= Agrostis gigantea Roth
SYN= Agrostis stolonifera subsp. gigantea (Roth) Schuebl. & Martens
Aira caryophyllea L.—**F2-Herbaceous**
SYN= Aira elegans Willd. ex Kunth
SYN= Aira capillaris Host
SYN= Aira caryophyllea var. capillaris (Host) Mutel
Alopecurus geniculatus L.—**F4-Herbaceous**
Alopecurus myosuroides Huds.—**F3-Herbaceous**

SYN= Alopecurus agrestis L.
Anthoxanthum aristatum Boiss.—**F3-Herbaceous**
SYN= Anthoxanthum odoratum var. puelii (Lecoq & Lamotte) Coss. & Durieu
Anthoxanthum odoratum L.—**F2-Herbaceous**
Arthraxon hispidus (Thunb.) Makino—**F3-Herbaceous**
SYN= Arthraxon hispidus var. cryptatherus (Hack.) Honda
Arundo donax L.—**F1-Woody**
Avena fatua L.—**F2-Herbaceous**
Avena sativa L.—**F3-Herbaceous**
Bothriochloa bladhii (Retz.) S.T. Blake—**F3-Herbaceous**
SYN= Andropogon caucasicus Trin.
SYN= Bothriochloa caucasica (Trin.) C.E. Hubbard
Bothriochloa ischaemum var. **songarica** (Rupr. ex F. & M.) Celarier & Harlan—**F1-Herbaceous**
SYN= Andropogon ischaemum var. songaricus Rupr. ex Fisch. & Mey.
Bothriochloa pertusa (L.) A. Camus—**F3-Herbaceous**
Brachiaria eruciformis (Sm.) Griseb.—**F3-Herbaceous**
Brachypodium distachyon (L.) Beauv.—**F3-Herbaceous**
Briza maxima L.—**F3-Herbaceous**
Briza minor L.—**F2-Herbaceous**
Bromus arvensis L.—**F2-Herbaceous**
SYN= Bromus japonicus Thunb. ex Murr.—
Bromus catharticus Vahl—**F2-Herbaceous**
SYN= Bromus unioloides Kunth
SYN= Bromus willdenowii Kunth
Bromus commutatus Schrad.—**F3-Herbaceous**
Bromus diandrus Roth—**F3-Herbaceous**
SYN= Bromus rigidus Roth
Bromus hordeaceus L.—**F2-Herbaceous**
SYN= Bromus hordeaceus L. subsp. molliformis (Lloyd) Maire & Weiller.
SYN= Bromus hordeaceus subsp. divaricatus (Bonnier & Layens) Kerg.
Bromus inermis Leyss.—**F3-Herbaceous**
SYN= Bromopsis inermis (Leyss.) Holub
Bromus japonicus Thunb. ex Murr.—**F2-Herbaceous**
Bromus lanceolatus Roth—**F3-Herbaceous**
Bromus rubens L.—**F2-Herbaceous**
Bromus secalinus L.—**F2-Herbaceous**
Bromus sterilis L.—**F3-Herbaceous**
Bromus tectorum L.—**F2-Herbaceous**
Chloris canterae Arechav.—**F2-Herbaceous**
Chloris divaricata R. Br.—**F3-Herbaceous**
SYN= Chloris cynodontioides Balansa
Chloris gayana Kunth—**F2-Herbaceous**
Coix lacryma-jobi L.—**F3-Herbaceous**
Cortaderia selloana (J.A. & J.H. Schultes) Aschers. & Graebn.—**F3-Woody**
Cynodon aethiopicus Clayton & Harlan—**F3-Herbaceous**
Cynodon dactylon (L.) Pers.—**F1-Herbaceous**
Cynodon magennisii Hurcombe—**F4-Herbaceous**
Cynodon nlemfuensis Vanderyst—**F3-Herbaceous**
Cynodon transvaalensis Burtt-Davy—**F4-Herbaceous**
Cynosurus echinatus L.—**F3-Herbaceous**
Dactylis glomerata L.—**F2-Herbaceous**
Dactyloctenium aegyptium (L.) Willd.—**F2-Herbaceous**
SYN= Cynosurus aegyptius L.
Desmazeria rigida (L.) Tutin—**F2-Herbaceous**
SYN= Catapodium rigidum (L.) Hubbard ex Dony
Dichanthium annulatum (Forsk.) Stapf—**F1-Herbaceous**
SYN= Andropogon annulatus Forsk.
Dichanthium aristatum (Poir.) C.E. Hubbard—**F1-Herbaceous**
Dichanthium sericeum (R. Br.) A. Camus—**F1-Herbaceous**
SYN= Andropogon sericeus R. Br.
Digitaria ischaemum (Schreb.) Schreb. ex Muhl.—**F2-Herbaceous**
Digitaria milanjiana (Rendle) Stapf—**F4-Herbaceous**
Digitaria sanguinalis (L.) Scop.—**F2-Herbaceous**
Digitaria violascens Link—**F2-Herbaceous**
SYN= Digitaria ischaemum var. violascens (Link) Radford
Echinochloa colona (L.) Link—**F2-Herbaceous**
Echinochloa crus-galli (L.) Beauv.—**F2-Herbaceous**
SYN= Echinochloa frumentacea Link
SYN= Echinochloa crus-galli var. frumentacea (Link) W. Wight
Echinochloa paludigena Wiegand—**F4-Herbaceous**
Ehrharta calycina Sm.—**F3-Herbaceous**
Eleusine indica (L.) Gaertn.—**F2-Herbaceous**
Elymus hispidus (P. Opiz) Meldris—**F2-Herbaceous**
Elymus ponticus (Podp.) Meldris—**F3-Herbaceous**
Elymus repens (L.) Gould—**F3-Herbaceous**
SYN= Agropyron repens (L.) Beauv.
Eragrostis airoides Nees—**F3-Herbaceous**
Eragrostis amabilis (L.) Wight & Arnolt ex Nees—**F3-Herbaceous**
SYN= Eragrostis tenella (L.) Beauv. ex Roemer & Schultes
Eragrostis barrelieri Daveau—**F2-Herbaceous**
Eragrostis cilianensis (All.) Vign. ex Janchen—**F2-Herbaceous**
Eragrostis curvula (Schrad.) Nees—**F2-Herbaceous**
Eragrostis lehmanniana Nees—**F1-Herbaceous**
Eragrostis minor Host—**F3-Herbaceous**
Eragrostis pilosa var. **perplexa** (Harvey) S. Koch—**F3-Herbaceous**
Eragrostis pilosa (L.) P. Beauv. var. pilosa—**F2-Herbaceous**
Eragrostis superba Peyr.—**F3-Herbaceous**
Eremochloa ophiuroides (Munro) Hack.—**F3-Herbaceous**
Eriochloa pseudoacrotricha (Stapf ex Thellung) Hubbard ex Blake—**F3-Herbaceous**
Eustachys caribaea (Spreng.) Herter—**F3-Herbaceous**
Eustachys retusa (Lag.) Kunth—**F2-Herbaceous**
Gastridium phleoides (Nees & Meyen) C.E. Hubbard—**F3-Herbaceous**
Hainardia cylindrica (Willd.) Greuter—**F3-Herbaceous**
SYN= Rottboellia cylindrica Willd.
SYN= Monerma cylindrica (Willd.) Coss. & Dur.
Hemarthria altissima (Poir.) Stapf & Hubbard—**F3-Herbaceous**
SYN= Manisuris altissima (Poir.) A.S. Hitchc.
Heteropogon melanocarpus (Ell.) Benth.—**F3-Herbaceous**
Holcus lanatus L.—**F3-Herbaceous**
Hordeum murinum L. subsp. **glaucum** (Steud.) Tzvelev—**F4-Herbaceous**
SYN= Hordeum glaucum Steud.

Hordeum murinum subsp. leporinum (Link) Arcang.—**F2-Herbaceous**
SYN= Critesion murinum subsp. leporinum (Link) A. Löve
SYN= Hordeum leporinum Link
Hordeum vulgare L.—**F3-Herbaceous**
Imperata cylindrica (L.) Beauv.—**F3-Herbaceous WATCH**
Ixophorus unisetus (J. Presl) Schltdl.—**F3-Herbaceous**
Lamarckia aurea (L.) Moench—**F3-Herbaceous**
Leptochloa chloridiformis (Hack. ex Stuck.) Parodi—**F3-Herbaceous**
Lolium arundinaceum (Schreb.) S.J. Darbyshire—**F2-Herbaceous**
SYN= Festuca arundinacea Schreb.
Lolium perenne L.—**F1-Herbaceous**
SYN= Lolium multiflorum Lam.
SYN= Lolium perenne subsp. multiflorum (Lam.) Husnot
SYN= Lolium perenne var. multiflorum (Lam.) Parnell
SYN= Lolium perenne subsp. italicum (A. Braun) Husnot
Lolium pratense (Huds.) S.J. Darbyshire—**F3-Herbaceous**
SYN= Festuca elatior L. p.p.
SYN= Festuca pratensis Huds.
Lolium rigidum Gaudin—**F4-Herbaceous**
SYN= Lolium perenne subsp. *rigidum* (Gaudin) Löve & Löve
Lolium temulentum L.—**F2-Herbaceous**
SYN= Lolium temulentum var. arvense (With.) Lilja
Luziola peruviana Juss. ex J. F. Gmel.—**F3-Herbaceous**
Melinis repens (Willd.) Zizka—**F2-Herbaceous**
SYN= Rhynchelytrum repens (Willd.) C.E. Hubbard
Mnesithea granularis (L.)—**F4-Herbaceous**
SYN= Hackelochloa granularis (L.) Kuntze
Microstegium vimineum (Trin.) A. Camus—**F3-Herbaceous WATCH**
Oryza sativa L.—**F2-Herbaceous**
Panicum antidotale Retz.—**F2-Herbaceous**
Panicum bergii Arech.—**F2-Herbaceous**
Panicum coloratum L.—**F2-Herbaceous**
Panicum miliaceum L.—**F3-Herbaceous**
Panicum repens L.—**F3-Herbaceous**
Panicum trichoides Sw.—**F3-Herbaceous**
Parapholis incurva (L.) C.E. Hubbard—**F2-Herbaceous**
SYN= Pholiurus incurvus (L.) Schinz & Thellung
Paspalum almum Chase—**F3-Herbaceous**
Paspalum convexum Humb. & Bonpl. ex Flueggé—**F3-Herbaceous**
Paspalum dilatatum Poir.—**F2-Herbaceous**
Paspalum hydrophilum Henr.—**F4-Herbaceous**
Paspalum malacophyllum Trin.—**F3-Herbaceous**
Paspalum notatum Alain ex Flugge—**F2-Herbaceous**
SYN= Paspalum notatum var. latiflorum J. Döll
SYN= Paspalum notatum var. saurae Parodi
Paspalum scrobiculatum L.—**F4-Herbaceous**
Paspalum urvillei Steud.—**F2-Herbaceous**
Pennisetum ciliare (L.) Link—**F1-Herbaceous**
SYN= Cenchrus ciliaris L.
Pennisetum glaucum (L.) R. Br.—**F3-Herbaceous**
SYN= Pennisetum americanum (L.) Leeke
SYN= Setaria glauca (L.) Beauv.
Pennisetum nervosum (Nees) Trin.—**F3-Herbaceous**
SYN= Cenchrus nervosus (Nees) Kuntze
Pennisetum purpureum Schumacher—**F3-Herbaceous**
Pennisetum villosum R. Br. ex Fresen.—**F2-Herbaceous**
SYN= Cenchrus longisetus M.C. Johnston
Phalaris arundinacea L.—**F3-Herbaceous**
Phalaris brachystachys Link—**F3-Herbaceous**
Phalaris canariensis L.—**F3-Herbaceous**
Phalaris minor Retz.—**F3-Herbaceous**
Phleum pratense L.—**F3-Herbaceous**
Phyllostachys aurea Carr. ex A.& C. Rivière—F2-Woody
Poa annua L.—**F2-Herbaceous**
Poa bulbosa L.—**F4-Herbaceous**
Poa compressa L.—**F3-Herbaceous**
Poa trivialis L.—**F4-Herbaceous**
Polypogon monspeliensis (L.) Desf.—**F2-Herbaceous**
Polypogon viridis (Gouan) Breistr.—**F2-Herbaceous**
Psathyrostachys juncea (Fisch.) Nevski—**F4-Herbaceous**
SYN= Elymus junceus Fisch.
Rostraria cristata (L.) Tzvelev—**F3-Herbaceous**
SYN= Koeleria gerardii (Vill.) Shinners
SYN= Koeleria phleoides (Vill.) Pers.
Rottboellia cochinchinensis (Lour.) W.D. Clayton—**F3-Herbaceous**
SYN= Aegilops exaltata L.
SYN= Manisuris exaltata (L.) Kuntze
SYN= Rottboellia exaltata (L.) L. f.
Saccharum officinarum L.—**F3-Herbaceous**
Sacciolepis indica (L.) Chase—**F3-Herbaceous**
Schismus barbatus (Loefl. ex L.) Thellung—**F3-Herbaceous**
Sclerochloa dura (L.) Beauv.—**F2-Herbaceous**
Secale cereale L.—**F3-Herbaceous**
SYN= Triticum cereale (L.) Salisb.
Setaria italica (L.) Beauv.—**F2-Herbaceous**
Setaria pumila (Poir.) Roem. & Schult.—**F2-Herbaceous**
Setaria verticillata (L.) Beauv.—**F2-Herbaceous**
Setaria viridis (L.) P. Beauv.—**F2-Herbaceous**
SYN= Setaria viridis var. major (Gaudin) Pospichal
Sorghum almum Parodi—**F4-Herbaceous**
Sorghum bicolor (L.) Moench—**F2-Herbaceous**
SYN= Sorghum saccharatum (L.) Moench
Sorghum halepense (L.) Pers.—**F1-Herbaceous**
Stenotaphrum secundatum (Walter) Kuntze—**F3-Herbaceous**
Themeda triandra Forssk.—**F3-Herbaceous**
Thinopyrum intermedium (Host) Barkworth & Dewey—**F4-Herbaceous**
SYN= Agropyron intermedium (Host) Beauv.
SYN= Elytrigia intermedia (Host) Nevski
SYN= Thinopyrum intermedium subsp. barbulatum (Schur) Barkworth & Dewey
Thinopyrum ponticum (Podp.) Liu & Wang—**F4-Herbaceous**
SYN= Agropyron elongatum (Host) Beauv.
SYN= Elymus elongatus (Host) Runemark
SYN= Elytrigia elongata (Host) Nevski
SYN= Elytrigia pontica (Podp.) Holub
Thinopyrum pycnanthum (Godr.) Barkworth—**F4-Herbaceous**

SYN= Agropyron pycnanthum (Godr.) Godr. & Gren.
SYN= Elymus pungens auct. non (Pers.) Melderis
SYN= Elymus pycnanthus (Godr.) Melderis
SYN= Elytrigia pycnanthes (Godr.) A. Löve
Triraphis mollis R. Br.—**F3-Herbaceous**
Triticum aestivum L.—**F3-Herbaceous**
Urochloa brizantha (Hochstetter ex A. Rich.) R. Webster—**F3-Woody**
SYN= Brachiaria brizantha (Hochstetter ex A. Rich.) Stapf
Urochloa maxima (Jacq.) R. Webster—**F1-Herbaceous**
Urochloa mosambicensis (Hack.) Dandy—**F3-Woody**
Urochloa mutica (Forsk.) T.Q. Nguyen—**F3-Herbaceous**
SYN= Brachiaria mutica (Forsk.) Stapf
SYN= Panicum muticum Forsk.
Urochloa panicoides Beauv.—**F3-Herbaceous**
Urochloa plantaginea (Link) R. Webster—**F3-Herbaceous**
SYN= Brachiaria plantaginea (Link) A.S. Hitchc.
Urochloa ramosa (L.) Nguyen—**F3-Herbaceous**
SYN= Brachiaria ramosa (L.) Stapf
Urochloa reptans (L.) Stapf.—**F2-Herbaceous**
SYN= Panicum reptans L.
SYN= Brachiaria reptans (L.) Gard. & Hubb.
Vulpia bromoides (L.) S.F. Gray—**F3-Herbaceous**
SYN= Festuca bromoides L.
SYN= Vulpia dertonensis (All.) Gola
Vulpia myuros (L.) K.C. Gmel.—**F2-Herbaceous**
SYN= Festuca myuros L.
SYN= Vulpia myuros var. hirsuta Hack.
Zea mays L.—**F3-Herbaceous**
Zea perennis (Hitchc.) Reeves & Manglesdorf—**F3-Herbaceous**
SYN= Euchlaena perennis Hitchc.

POLYGONACEAE
Antigonon leptopus Hook. & Arn.—**F3-Herbaceous**
Emex spinosa (L.) Campd.—**F3-Herbaceous**
SYN= Rumex spinosus L.
Fagopyrum esculentum Moench—**F3-Herbaceous**
Polygonum arenastrum Jord. ex Boreau—**F2-Herbaceous WATCH**
SYN= Polygonum aviculare var. arenastrum (Jord. ex Boreau) Rouy
Polygonum argyrocoleon Steud. ex Kunze—**F3-Herbaceous**
Polygonum aviculare L.—**F2-Herbaceous**
Polygonum caespitosum Blume—**F3-Herbaceous**
Polygonum caespitosum var. **longisetum** (Bruijn) A.N. Steward—**F3-Herbaceous**
Polygonum convolvulus L.—**F2-Herbaceous**
Polygonum hydropiper L.—**F3-Herbaceous**
SYN= Persicaria hydropiper (L.) Opiz
Polygonum orientale L.—**F3-Herbaceous**
SYN= Persicaria orientalis (L.) Spach
Polygonum meisnerianum var. **beyrichianum** (C. & S.) Meisn.—**F3-Herbaceous**
Polygonum scandens L.
Polygonum persicaria L.—**F2-Herbaceous WATCH**
Rumex acetosella L.—**F3-Herbaceous**
Rumex conglomeratus Murr.—**F3-Herbaceous**
Rumex crispus L.—**F2-Herbaceous**
Rumex obtusifolius L.—**F3-Herbaceous**
Rumex paraguayensis Parodi—**F3-Herbaceous**
Rumex pulcher L.—**F2-Herbaceous**

POLYPODIACEAE
Nephrolepis exaltata (L.) Schott—**F3-Herbaceous**

PONTEDERIACEAE
Eichhornia crassipes (Mart.) Solms—**F1-Woody**

POTAMOGETONACEAE
Potamogeton crispus L.—**F2-Woody**

PRIMULACEAE
Anagallis arvensis L.—**F2-Herbaceous**

PSILOTACEAE
Psilotum nudum (L.) P. Beauv.—**F3-Herbaceous**

PTERIDACEAE
Cheilanthes notholaenoides (Desv.) Maxon ex Weatherby—**F3-Herbaceous**
Pteris multifida Poir.—**F3-Herbaceous**
Pteris vittata L.—**F3-Herbaceous**

RANUNCULACEAE
Adonis annua L.—**F3-Herbaceous**
Clematis terniflora DC.—**F2-Herbaceous WATCH**
SYN= Clematis dioscoreifolia Levl. & Vaniot
Consolida ajacis (L.) Schur—**F2-Herbaceous**
SYN= Delphinium ajacis L.
SYN= Delphinium ambiguum L.
Consolida orientalis (J. Gay) Schroedinger—**F4-Herbaceous**
SYN= Delphinium orientale J. Gay
Ranuncus ficaria L.—**F3-Herbaceous**
Ranunculus marginatus var. **trachycarpus** (Fisch. & Mey.) Arn.—**F3-Herbaceous**
SYN= Ranunculus trachycarpus Fisch. & Mey.
Ranunculus muricatus L.—**F2-Herbaceous**
Ranunculus parviflorus L.—**F2-Herbaceous**
Ranunculus platensis Spreng.—**F3-Herbaceous**
Ranunculus repens L.—**F2-Herbaceous**
Ranunculus sardous Crantz—**F2-Herbaceous**
SYN= Ranunculus parvulus L.
Ranunculus trilobus Desf.—**F3-Herbaceous**

RHAMNACEAE
Hovenia dulcis Thunb.—**F3-Woody**
Paliurus spina-christi P. Mill.—**F3-Woody**
Ziziphus zizyphus (L.) Karst.—**F3-Woody**
SYN= Ziziphus jujuba P. Mill.

ROSACEAE
Aphanes microcarpa (Boiss. & Reut.) Rothm.—**F3-Herbaceous**
SYN= Alchemilla microcarpa Boiss. & Reut.
Duchesnea indica (Andr.) Focke—**F2-Herbaceous**
Photinia serratifolia (Desf.) Kalkm.—**F3-Woody WATCH**
Potentilla recta L.—**F3-Herbaceous**
Prunus domestica L.—**F3-Woody**
Prunus persica (L.) Batsch—**F3-Woody**
Pyracantha coccinea M. Roemer—**F3-Woody**
Pyracantha fortuneana (Maxim.) H.L. Li—**F3-Woody**

Pyracantha koidzumii (Hayata) Rehder—**F3-Woody**
Pyrus calleryana Dcne.—F2-Woody
Pyrus communis L.—**F3-Woody**
Rosa bracteata J.C. Wendl.—**F1-Woody**
Rosa eglanteria L.—**F3-Woody**
Rosa laevigata Michx.—F2-Woody
Rosa micrantha Borrer ex Sm.—**F3-Woody**
Rosa multiflora Thunb. ex Murr.—**F1-Woody**
Rosa tomentosa Sm.—**F3-Woody**
Rubus bifrons Vest ex Tratt.—**F3-Herbaceous**

RUBIACEAE
Asperula arvensis L.—**F3-Herbaceous**
Cruciata pedemontana (Bellardi) Ehrend.—**F2-Herbaceous**
SYN= Galium pedemontanum (Bellardi) All.
Galium anglicum Hudson—**F3-Herbaceous**
Galium aparine L.—**F2-Herbaceous**
Paederia foetida L.—**F3-Woody**
SYN= Paederia scandens (Lour.) Merr.
Richardia scabra L.—**F2-Herbaceous**
Sherardia arvensis L.—**F2-Herbaceous**
Spermacoce verticillata L.—**F3-Herbaceous**
SYN= Borreria verticillata (L.) G.F.W. Mey.

RUTACEAE
Citrus aurantium L.—**F3-Woody**
Poncirus trifoliata (L.) Raf.—F2-Woody
Ruta chalapensis L.—**F3-Herbaceous**
Ruta graveolens L.—**F3-Herbaceous**
Triphasia trifolia (Burm. f.) P. Wilson—**F3-Woody**

SALICACEAE
Populus alba L.—**F3-Woody**
Populus nigra L.—**F3-Woody**
SYN= Populus italica (Du Roi) Moench
Salix ×pendulina Wenderoth—**F3-Woody**
SYN= Salix babylonica auct. non L. p.p.

SALVINIACEAE
Salvinia molesta Mitchell—**F1-Woody**
Salvinia minima Baker—**F2-Woody**

SAPINDACEAE
Cardiospermum halicacabum L.—**F2-Herbaceous**
Cupaniopsis anacardioides (A. Rich.) Radlk.—**F3-Woody**
Koelreuteria elegans (Seem.) A.C. Smith—**F3-Woody**
SYN= Koelreuteria paniculata Laxm.

SCROPHULARIACEAE
Bacopa repens (Sw.) Wettst.—**F3-Herbaceous**
Bellardia trixago (L.) All.—**F2-Herbaceous**
Chaenorhinum minus (L.) Lange—**F3-Herbaceous**
Kickxia elatine (L.) Dumort.—**F3-Herbaceous**
Limnophila sessiliflora (Vahl) Blume—**F2-Woody**
Linaria vulgaris P. Mill.—**F3-Herbaceous**
Lindernia crustacea (L.) F. Muell.—**F3-Herbaceous**
Mazus pumilus (Burm. f.) Steenis—**F2-Herbaceous**
SYN= Mazus japonicus (Thunb.) Kuntze
Parentucellia viscosa (L.) Caruel—**F2-Herbaceous**
Verbascum blattaria L.—**F2-Herbaceous**
Verbascum thapsus L.—**F2-Herbaceous**
Verbascum virgatum Stokes—**F3-Herbaceous**
Veronica agrestis L.—**F4-Herbaceous**
Veronica arvensis L.—**F2-Herbaceous**
Veronica persica Poir.—**F2-Herbaceous**
Veronica polita Fries—**F2-Herbaceous**

SIMAROUBACEAE
Ailanthus altissima (P. Mill.) Swingle—**F1-Woody**

SOLANACEAE
Cestrum diurnum L.—**F3-Woody**
Cestrum nocturnum L.—**F3-Woody**
Cestrum parqui L'Hér.—**F3-Woody**
Datura inoxia P. Mill.—**F3-Herbaceous**
Datura stramonium L.—**F2-Herbaceous**
Lycianthes asarifolia (Kunth & Bouché) Bitter—**F3-Herbaceous**
Lycium barbarum L.—**F3-Woody**
Nicotiana glauca Graham—F2-Woody
Nicotiana longiflora Cav.—**F4-Herbaceous**
Nicotiana tabacum L.—**F3-Herbaceous**
Nierembergia hippomanica Miers—**F3-Herbaceous**
Petunia integrifolia (Hook.) Schinz & Thellung—**F3-Herbaceous**
SYN= Petunia violacea Lindl.
Physalis philadelphica Lam.—**F4-Herbaceous**
SYN= Physalis ixocarpa Hornem.
Salpichroa origanifolia (Lam.) Baill.—**F3-Herbaceous**
SYN= Salpichroa rhomboidea (Gillies & Hook.) Miers
Schizanthus pinnatus Ruiz & Pavón—**F4-Herbaceous**
Solanum capsicastrum Link ex Schauer—**F3-Herbaceous**
Solanum capsicoides All.—**F3-Herbaceous**
Solanum diphyllum L.—**F3-Herbaceous**
Solanum erianthum D. Don—**F3-Herbaceous**
Solanum lycopersicum var. **cerasiforme** (Dunal) Spooner et al.—**F3-Herbaceous**
SYN= Lycopersicon esculentum var. cerasiforme (Dunal) Alef.
Solanum lycopersicum Lam. var. **lycopersicum**—**F3-Herbaceous**
SYN= Lycopersicon esculentum P. Mill.
Solanum pseudocapsicum L.—**F3-Herbaceous**
Solanum sarrachoides Sendt.—**F3-Herbaceous**
Solanum sisymbriifolium Lam.—**F3-Herbaceous**
Solanum viarum Dunal—**F1-Herbaceous**

SPHENOCLEACEAE
Sphenoclea zeylanica Gaertn.—**F3-Herbaceous**

STERCULIACEAE
Firmiana simplex (L.) W. Wight—**F3-Woody**
Melochia corchorifolia L.—**F2-Herbaceous**

TAMARICACEAE
Tamarix aphylla (L.) Karst.—**F1-Woody**
Tamarix chinensis Lour.—**F1-Woody**
including T. pentandra Pallas, T. ramosissima Ledeb.
Tamarix gallica L.—**F1-Woody**
including T. canariensis Willd., T. africana Poir.
Tamarix parviflora DC.—**F1-Woody**

THELYPTERIDACEAE

Macrothelypteris torresiana (Gaud.) Ching—**F3-Herbaceous**
SYN= Dryopteris uliginosa (Kunze) C. Christens.
SYN= Thelypteris torresiana (Gaud.) Alston

THYMELAEACEAE

Thymelaea passerina (L.) Coss. & Germ.—**F3-Herbaceous**

ULMACEAE

Ulmus parvifolia Jacq.—**F3-Woody WATCH**
Ulmus pumila L.—**F1-Woody**

URTICACEAE

Boehmeria nivea (L.) Gaud.—**F4-Herbaceous**
Parietaria judaica L.—**F4-Herbaceous**
Pilea microphylla (L.) Lieb.—**F3-Herbaceous**
Urtica urens L.—**F3-Herbaceous**

VALERIANACEAE

Valerianella locusta (L.) Betcke—**F3-Herbaceous**

VERBENACEAE

Clerodendrum bungei Steud.—**F3-Woody**
Clerodendrum indicum (L.) Kuntze—**F3-Woody**
Duranta erecta L.—**F3-Woody**
SYN= Duranta repens L. var. alba (Mast.) Bailey
SYN= Duranta repens var. repens
Glandularia ×hybrida (Grönland & Rümpler) Nesom & Pruski—**F4-Herbaceous**
SYN= Verbena hybrida Grönland & Rümpler
Glandularia pulchella (Sweet) Troncoso—**F2-Herbaceous**
SYN= Verbena pulchella Sweet
SYN= Verbena tenuisecta Briq.
Lantana camara L.—F2-Woody
Lantana montevidensis (Spreng.) Briq.—**F3-Woody**
SYN= Lantana sellowiana Link & Otto
SYN= Lippia montevidensis Spreng.
Verbena bonariensis L.—**F2-Herbaceous**
Verbena brasiliensis Vell.—**F2-Herbaceous WATCH**
Verbena litoralis Kunth—**F4-Herbaceous**
Verbena rigida Spreng.—**F2-Herbaceous**
Vitex agnus-castus L.—**F2-Woody WATCH**
Vitex negundo L.—**F3-Woody**

VIOLACEAE

Viola tricolor L.—**F3-Herbaceous**

VITACEAE

Cayratia japonica (Thunb.) Gagnepain—**F3-Herbaceous**

ZYGOPHYLLACEAE

Kallstroemia maxima (L.) Hook. & Arn.—**F3-Herbaceous**
Peganum harmala L.—**F2-Herbaceous**
Tribulus cistoides L.—**F4-Herbaceous**
Tribulus terrestris L.—**F2-Herbaceous**
Zygophyllum fabago L.—**F3-Herbaceous**

APPENDIX 2

Non-native species in Texas ranked as F1. For aquatic species, the number of counties of occurrence is indicated in square brackets.

F1-WOODY (Trees, shrubs, subshrubs, and woody vines)

Ailanthus altissima
Arundo donax
Ligustrum lucidum
Ligustrum quihoui
Ligustrum sinense
Lonicera japonica
Melia azedarach
Nandina domestica
Rosa bracteata
Rosa multiflora
Tamarix aphylla
Tamarix chinensis (incl. *T. pentandra, T. ramosissima*)
Tamarix gallica (incl. *T. canariensis, T. africana*)
Tamarix parviflora
Triadica sebifera
Ulmus pumila
Wisteria sinensis

F1-HERBACEOUS (Annual and perennial herbs and grasses)

Atriplex semibaccata
Bassia scoparia
Bothriochloa ischaemum var. **songarica**
Carduus nutans subsp. **macrocephalus**
Centaurea melitensis
Cynodon dactylon
Cyperus entrerianus
Dichanthium annulatum
Dichanthium aristatum
Dichanthium sericeum
Eragrostis lehmanniana
Lolium perenne
Lygodium japonicum
Marrubium vulgare
Melilotus albus
Melilotus indicus
Melilotus officinalis
Orobanche ramosa
Pennisetum ciliare
Rapistrum rugosum
Salsola kali subsp. **pontica**
Salsola tragus
Solanum viarum
Sorghum halepense
Urochloa maxima

F1-AQUATIC

Alternanthera philoxeroides [20+]
Colocasia esculenta [11]
Eichhornia crassipes [25]
Hydrilla verticillata [6]
Myriophyllum aquaticum [18]
Myriophyllum spicatum [10]
Nasturtium officinale [35]
Pistia stratiotes [10 or more]
Salvinia molesta [10]

APPENDIX 3

Non-native species in Texas ranked as F2. For aquatic species, the number of counties of known occurrence is indicated in square brackets.

F2-WOODY (Trees, shrubs, subshrubs, and woody vines)

Albizia julibrissin
Broussonetia papyrifera
Hypericum perforatum
Lagerstroemia indica
Lantana camara
Morus alba
Nicotiana glauca
Phyllostachys aurea
Poncirus trifoliata
Pueraria montana var. **lobata**
Pyrus calleryana
Rosa laevigata
Vitex agnus-castus

F2-HERBACEOUS (Annual and perennial herbs and grasses)

Aegilops cylindrica
Aira caryophyllea
Alternanthera caracasana
Amaranthus blitum
Ammi majus
Anagallis arvensis
Anthemis cotula
Anthoxanthum odoratum
Arabidopsis thaliana
Arenaria serpyllifolia
Avena fatua
Bellardia trixago
Brassica rapa
Briza minor
Bromus arvensis
Bromus catharticus
Bromus hordeaceus
Bromus japonicus
Bromus rubens
Bromus secalinus
Bromus tectorum
Buglossoides arvensis
Bupleurum rotundifolium
Camelina microcarpa
Capsella bursa-pastoris
Cardamine debilis
Cardamine hirsuta
Cardiospermum halicacabum
Carduus pycnocephalus
Centaurea cyanus
Centaurium muhlenbergeii
Centaurium pulchellum
Cerastium fontanum
Cerastium glomeratum
Cerastium pumilum
Chenopodium album
Chenopodium ambrosioides
Chenopodium murale
Chloris canterae
Chloris gayana
Chorispora tenella
Cichorium intybus
Cirsium vulgare
Clematis terniflora
Commelina communis
Conium maculatum
Conringia orientalis
Consolida ajacis
Convolvulus arvensis
Conyza bonariensis
Coronilla varia
Coronopus didymus
Croton argenteus
Cruciata pedemontana
Cucumis melo
Cuphea carthagenensis
Cyclospermum leptophyllum
Cyperus difformis
Cyperus involucratus
Cyperus iria
Cyperus rotundus
Dactylis glomerata
Dactyloctenium aegyptium
Datura stramonium
Daucus carota
Descurainia sophia
Desmazeria rigida
Digitaria ischaemum
Digitaria sanguinalis
Digitaria violascens
Diplotaxis muralis
Duchesnea indica
Echinochloa colona
Echinochloa crus-galli
Eleusine indica
Elymus hispidus
Eragrostis barrelieri
Eragrostis cilianensis
Eragrostis curvula
Eragrostis pilosa var. **pilosa**
Erodium cicutarium
Eruca vesicaria subsp. **sativa**
Erucastrum gallicum
Erysimum repandum
Eustachys retusa
Facelis retusa
Fatoua villosa
Galinsoga parviflora
Galium aparine
Gamochaeta antillana
Gamochaeta calviceps
Gamochaeta coarctata
Gamochaeta pensylvanica
Geranium dissectum
Gibasis pellucida
Glandularia pulchella
Gomphrena globosa
Hedera helix
Hedypnois cretica
Heliotropium amplexicaule
Heliotropium indicum
Holosteum umbellatum
Hordeum murinum subsp. **leporinum**
Hypochaeris brasiliensis var. **tweediei**
Hypochaeris glabra
Hypochaeris microcephala var. **albiflora**
Hypochaeris radicata
Ipomoea carnea
Juncus capitatus
Kummerowia striata
Lactuca serriola
Lamium amplexicaule
Lamium purpureum
Lathyrus hirsutus
Leonotis nepetifolia
Lespedeza cuneata
Leucanthemum vulgare
Lolium arundinaceum
Lolium temulentum
Malva neglecta
Malva parviflora
Malvastrum coromandelianum
Mazus pumilus
Medicago arabica
Medicago lupulina
Medicago minima
Medicago orbicularis
Medicago polymorpha
Medicago sativa
Melinis repens
Melochia corchorifolia
Mollugo cerviana
Murdannia nudiflora
Oenothera cordata
Onopordum acanthium
Oryza sativa

Oxalis articulata
Oxalis debilis
Panicum antidotale
Panicum bergii
Panicum coloratum
Parapholis incurva
Parentucellia viscosa
Paspalum dilatatum
Paspalum notatum
Paspalum urvillei
Peganum harmala
Pennisetum villosum
Perilla frutescens
Petrorhagia dubia
Phyllanthus urinaria
Plantago lanceolata
Plantago major
Poa annua
Polycarpon tetraphyllum
Polygonum arenastrum
Polygonum aviculare
Polygonum convolvulus
Polygonum persicaria
Polypogon monspeliensis
Polypogon viridis
Prunella vulgaris
Pseudognaphalium luteoalbum
Ranunculus muricatus
Ranunculus parviflorus
Ranunculus repens
Ranunculus sardous
Richardia scabra
Ricinus communis
Rumex crispus
Rumex pulcher
Scabiosa atropurpurea
Sclerochloa dura
Scorzonera laciniata
Senecio vulgaris
Senna occidentalis
Sesbania emerus
Setaria italica
Setaria pumila
Setaria verticillata
Setaria viridis
Sherardia arvensis
Silene gallica
Sinapis arvensis
Sisymbrium altissimum
Sisymbrium irio
Sisymbrium officinale
Solivia anthemiifolia
Soliva sessilis
Soliva stolonifera
Sonchus asper
Sonchus oleraceus
Sorghum bicolor
Stachys floridana
Stellaria media
Stellaria pallida
Taraxacum laevigatum
Taraxacum officinale
Thlaspi arvense
Torilis arvensis
Torilis nodosa
Tragopogon dubius
Tragopogon porrifolius
Tribulus terrestris
Trifolium dubium
Trifolium incarnatum
Trifolium polymorphum
Trifolium repens
Trifolium resupinatum
Trifolium vesiculosum
Urochloa reptans
Vaccaria hispanica
Vaccaria pyramidata
Verbascum blattaria
Verbascum thapsus
Verbena bonariensis
Verbena brasiliensis
Verbena rigida
Veronica arvensis
Veronica persica
Veronica polita
Vicia sativa subsp. **nigra**
Vicia tetrasperma
Vicia villosa subsp. **villosa**
Vinca major
Vulpia myuros
Xanthium spinosum
Youngia japonica

F2-AQUATIC

Ceratopteris thalictroides [3]
Cryptocoryne beckettii [1]
Egeria densa [3]
Hydrocleys nymphoides [2]
Hygrophila polysperma [2]
Landoltia punctata [6]
Limnophila sessiliflora [2]
Ludwigia grandiflora subsp. **grandiflora** [3]
Ludwigia grandiflora subsp. **hexapetala** [9]
Nomaphila stricta [1]
Nymphoides indica [1]
Nymphoides peltata [2]
Ottelia alismoides [1]
Potamogeton crispus [8]
Salvinia minima [2]
Xanthosoma sagittifolium [1]

APPENDIX 4

Watch List: non-native species in Texas potentially ranked as F1. All F2 aquatic species are included.

From F2-WOODY:

Hypericum perforatum
Pueraria montana var. **lobata**
Pyrus calleryana
Vitex agnus-castus

From F3-WOODY:

Ardisia crenata
Casuarina equisetifolia
Cinnamomum camphora
Elaeagnus angustifolia
Leucaena leucocephala
Lonicera maackii
Macfadyena unguis-cati
Photinia serratifolia
Pistacia chinensis
Schinus molle
Schinus terebinthifolius
Ulmus parvifolia

From F2-HERBACEOUS:

Carduus tenuiflorus
Cirsium vulgare
Clematis terniflora
Lespedeza cuneata
Perilla frutescens
Polygonum arenastrum
Polygonum persicaria
Stachys floridana
Torilis arvensis
Verbena brasiliensis

From F3-HERBACEOUS:

Cryptostegia grandiflora
Imperata cylindrica
Microstegium vimineum

from F2-AQUATIC:

Ceratopteris thalictroides
Cryptocoryne beckettii
Egeria densa
Hydrocleys nymphoides
Hygrophila polysperma
Landoltia punctata
Limnophila sessiliflora
Ludwigia grandiflora subsp. **grandiflora**
Ludwigia grandiflora subsp. **hexapetala**
Nomaphila stricta
Nymphoides indica
Nymphoides peltata
Ottelia alismoides
Potamogeton crispus
Salvinia minima
Xanthosoma sagittifolium

Potential and expanding new arrivals with global warming in south and coastal Texas:

Caesalpina bonduc
Canavalia rosea
Cassytha filiformis
Conocarpus erectus
Laguncularia racemosa
Rhizophora mangle
Scaveola plumieri

ACKNOWLEDGMENTS

The authenticity of this report, especially in the F1 species and Watch List but also in discussion of concepts and other topics, owes to contributions from Bill Carr, Laura Hansen, Stephan Hatch, Eric Keith, Barney Lipscomb, Andy McDonald, Michael McRoberts, Tom Patterson, Jackie Poole, Mike Powell, Nelson Rich, Monique Reed, David Rosen, Jason Singhurst, Bruce Sorrie, Damon Waitt, and Justin Williams. Detailed journal reviews by Jackie Poole, Damon Waitt, and Bruce Hoagland were valuable in refinement of the ranking protocols—and the detailed commentary by Jackie Poole on everything from A to Z is appreciated beyond expression.

REFERENCES

APRS Implementation Team. 2000. Alien plants ranking system (Version 5.1): A cooperative effort of the National Park Service, Ripon College, University of Minnesota, and the U.S. Geological Survey. Northern Prairie Wildlife Research Center Online, Jamestown, North Dakota. <http://www.npwrc.usgs.gov/resource/literatr/aprs/index.htm> (Version 30SEP2002).

Austin City Connection. 2009. Invasive plants to avoid. City of Austin. <http://www.ci.austin.tx.us/growgreen/invasive.htm>

Carlson, M.L., I.V. Lapina, M. Shephard, J.S. Conn, R. Densmore, P. Spencer, J. Heys, J. Riley, and J. Nielsen. 2008. Invasiveness ranking system for non-native plants of Alaska. U.S.D.A., Forest Service Alaska Region R10-TP-143. Anchorage, Alaska.

Correll, D.S. and M.C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Research Foundation, Renner, Texas.

Hatch, S.L., K.N. Gandhi, and L.E. Brown. 1990. Checklist of the vascular plants of Texas. MP-1665, Texas Agric. Expt. Station, Texas A&M Univ., College Station.

Heffernan, K.E., P.P. Coulling, J.F. Townsend, and C.J. Hutto. 2001. Ranking invasive exotic plant species in Virginia. Natural Heritage Technical Report 01-13. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, Virginia. <http://www.dcr.virginia.gov/natural_heritage/documents/rankinv.pdf>

Invaders of Texas. 2009. Invaders of Texas: a citizen science program to detect and report invasive species. <http://www.texasinvasives.org/invaders/index.php>

Johnston, M.C. 1990. The vascular plants of Texas: a list, up-dating the 'Manual of the vascular plants of Texas.' Second edition. Published by the author.

Jordan, M.J. G. Moore, and T.W. Weldy. 2009. New York State plant ranking system for evaluating non-native plant species for invasiveness (DRAFT). <http://nyis.info/PlantAssessments/Assets/NY_Invasive_Plant_Ranking_Intro.pdf>

Morse, L.E., J.M. Randall, N. Benton, R. Hiebert, and S. Lu. 2004. An invasive species assessment protocol: evaluating non-native plants for their impact on biodiversity. Version 1. NatureServe, Arlington, Virginia. <http://www.natureserve.org/library/invasiveSpeciesAssessmentProtocol.pdf>

Nesom, G.L. 2000. Which non-native plants are included in floristic accounts? Sida 19:189–193.

Nesom, G.L. 2009a. Non-native species naturalized in Texas: reported since 1970. Documentation for the full list. <http://guynesom.com/texnonnativeNEWweb.htm>

Nesom, G.L. 2009b. Notes on non-native Asteraceae in Texas. Phytologia 91:325–332.

NTWGS. 2009. Prohibited plant species. North Texas Water Garden Society. <http://www.ntwgs.org/articles/illegalAquatics.html#the%20list%20>

Tennessee EPPC. 2001. Tennessee invasive exotic plant list. Research Committee of the Tennessee Exotic Plant Pest Council. <http://www.tneppc.org/Invasive_Exotic_Plant_List/Invasive%20List%20Introduction.htm>

TDA. 2009. Noxious plant list. Texas Department of Agriculture. <http://info.sos.state.tx.us/fids/04_0019_0300-1.html>

TexasInvasives.org. 2009. Invasive Plant Database. <http://www.texasinvasives.org/invasives_database/>

TPWD 2009. Prohibited exotic species. Texas Parks and Wildlife Department. Austin, Texas. <http://www.tpwd.state.tx.us/huntwild/wild/species/exotic/#plant>

Turner, B.L., H. Nichols, G. Denny, and O. Doron. 2003. Atlas of the vascular plants of Texas. Vol. I, Dicots; Vol. II, Monocots. Sida, Bot. Misc. 24, 1 and 2.

USDA, NRCS. 2009. The PLANTS Database. National Plant Data Center, Baton Rouge, LA 70874-4490 USA. <http://plants.usda.gov/>

Warner, P.J., C.C. Bossard, M.L. Brooks, J.M. DiTomaso, J.A. Hall, A.M. Howald, D.W. Johnson, J.M. Randall, C.L. Roye, M.M. Ryan, and A.E. Stanton. 2003. Criteria for categorizing invasive non-native plants that threaten wildlands. California Exotic Pest Plant Council and Southwest Vegetation Management Association. <http://www.cal-ipc.org/ip/inventory/pdf/Criteria.pdf>

Postscript.—Since preparation of this report, various minor changes have been made to the lists. The whole set of information on Texas non-native plants, including these changes and additional commentary, is posted on the internet—see "Non-natives" at <http://www.guynesom.com/Texasplantsweb.htm>. The internet information is frequently updated as new data become available and as reassessments are made. In order to reflect the input of Texas botanists to the genesis and development of the information, the set of online data is cited as below.

Nesom, G.L., J.L. Aplaca, W.R. Carr, N.L. Fowler, L.L. Hansen, S.L. Hatch, B.W. Hoagland, W.C. Holmes, E.L. Keith, B.L. Lipscomb, B.R. MacRoberts, M.H. MacRoberts, J.A. McDonald, T.F. Patterson, J.M. Poole, A.M. Powell, N. Rich, M.D. Reed, D.J. Rosen, J.R. Singhurst, B.A. Sorrie, B.L. Turner, D.E. Waitt, and J.K. Williams. 2009. Non-native plants of Texas: Overview of occurrence and invasiveness assessments. <http://www.guynesom.com/TexasNonnativeMENUweb.htm>

The total number of non-native plants species in Texas now is 820 and a relatively small number of rankings have been modified. The Watch List has been expanded with additions of these: *Acroptilon repens*, *Carduus acanthoides*, *Cayratia japonica*, *Colocasia esculenta*, *Cortaderia selloana*, *Dioscorea bulbifera*, *Elymus repens*, *Gibasis pellucida*, *Lespedeza bicolor*, *Lolium arundinaceum*, and *Pyracantha koidzumii*. As with many of the F1 and F2 species, some of the Watch List species already are so widespread that it is unlikely that they can be eradicated or even controlled except by sustained efforts on local levels. From among the Watch List species, a subset is indicated as a "**Super Watch List,**" those species that perhaps can be removed from the Texas landscape before they become impossible to control. A newly added **Expected List** records species not currently known with certainty in Texas but that occur in nearby areas—each of these is aggressively invasive and ecologically damaging, and there is a high probability that each soon will reach Texas: *Alliaria petiolata*, *Ampelopsis brevipedunculata*, *Berberis thunbergii*, *Celastrus orbiculatus*, *Centaurea stoebe* ssp. *micranthos*, *Centaurea solstitialis*, *Cirsium arvense*, *Dioscorea alata*, *Elaeagnus pungens*, *Elaeagnus umbellata*, *Euonymus alatus*, *Euonymus fortunei*, *Euphorbia esula*, *Halogeton glomeratus*, *Lonicera morrowii*, *Lygodium microphyllum*, *Melaleuca quinquenervia*, *Miscanthus sinensis*, *Phalaris aquatica*, *Pennisetum setaceum*, *Polygonum cuspidatum*, *Schismus arabicus*, *Setaria faberi*, *Typha angustifolia*, and *Wisteria floribunda*.

BOOK REVIEW

Tatyana A. Lobova, Cullen K. Geiselman, and Scott A. Mori. 2009. **Seed Dispersal by Bats in the Neotropics.** (ISBN 978-089327-501-3, hbk.). Memoirs of The New York Botanical Garden, vol. 101. The New York Botanical Garden Press, 200th Street and Kazimiroff Boulevard, Bronx, New York 10458-5126, U.S.A. (**Orders:** www.nybgpress.org, nybgpress@nybg.org, 1-718-817-8721, 1-718-817-8842 fax). $70.00, 492 pp., 24 b&w illustrations + 32 color plates with more than 200 photographs, 7" × 10".

A beautiful cover illustration by Michael Rothman of the greater spear-nosed bat (*Phyllostomus hastatus*) flying away from a fruit of sapucaia (*Lecythis pisonis*) with a seed is how we are introduced to this monographic text that treats both the zoological and botanical aspects of bat-mediated seed dispersal (although with a slightly more botanical weight). This text represents a five-year intensive study that includes a thorough and well-cited literature survey of the topic, as well as a detailed account of field work and the results of the analyses that follow. It would be a delightful introduction for any student interested in animal-plant interactions, as well as an important addition to the library of any researcher concerning himself either with any of the 549 plant species mentioned or with bat biology.

There are five main sections, consisting of an introduction, conclusion, materials and methods, and the two largest sections: **Frugivorous bats** and **Plants dispersed by bats.** The former is divided into discussions of obligate and opportunistic frugivores, and provides a thorough discussion of each frugivorous bat species (organized by subfamily), including notes on "Diet Specificity, Seasonality, and Selectivity", "Foraging Strategy", and "Results for French Guiana". The **Plants dispersed by bats** section contains detailed plant treatments (sorted by family) divided into "Bat Dispersed Species in CFG[Central French Guiana]" and "Possible Bat Dispersed Species in CFG"; both these contain fruit descriptions, while the former also includes specific reference to the bat species that disperses it.

The appendices provide easy-to-use references if one should choose to further investigate either the bats dispersing plants (Appendix III) or the plants dispersed by bats (Appendix II). Appendix II also contains references to literature that is fully cited across 28 pages in the Literature Cited section. There is a 9-page glossary that assists the reader with the botanical and dispersal terminology referred to throughout the text. Appendix I details the diaspore collection vouchers yet unfortunately does not mention where these collections are housed.

The introduction does an excellent job of surveying the existing literature on the topic of bat dispersal, with easy to interpret tables and a clear message of the importance of a monographic publication of this sort. In the materials and methods section, we find that the study is supported by the long time botanical work at the study site of co-author Scott Mori, among others. There are beautifully presented color plates containing photographs of infructescences, fruits, and seeds of many of the families described in the text, which will likely be of particular aid in identification. The authors include both native and cultivated plant species in their survey, indicating this status in the descriptions. They make note of the discrepancies in comparing the literature, when different terminologies were used, plants were misidentified, or different taxonomic concepts were applied. Perhaps the most interesting portion of the book is found in the analysis of the characters of bat-dispersed plants (p. 103). Here the results of the study are summarized and analyzed with various statistics.

The authors analyzed fleshy fruited species that were determined suitable for animal consumption, and included the following characters for analysis: plant life form and habit, successional status, fruit type, infructescence position, fruit aggregation and position, plant part bats feed on, color of the edible part, part digested, diaspore, diaspore size, and bat dispersal type. Other characters that were discussed, but not statistically treated included fruit aroma, maturation time and nutritional content.

The authors summarize their results by the characters analyzed, and while some of their results support existing lines of thinking, there are a few results that surprise and shed light on new directions requiring further exploration (a particularly useful thing for students seeking projects in this field). The results are compared to those found at other study sites in the neotropics, although the only study with which they could provide any useful comparisons (after modifying the organization of their data) were those completed at Barro Colorado Island in Panama.

The authors identify the six top families (in terms of number of species) most sought after by bats in the neotropics as the Piperaceae (Pepper Family), Araceae (Philodendron Family), Cyclanthaceae (Panama Hat Family), Solanaceae (Potato Family), Moraceae (Mulberry Family), and Clusiaceae (Mangosteen Family). It is suggested that observed differences across study sites in the relative importance of these families has to do with forest structure and plant and bat communities. They generalize the plant characters preferred by bats to include those plants that are members of the largest plant families, have wide distributions, produce fruit in abundance throughout the year, are primarily dispersed by bats, have fruit that are soft and defense-less with multiple seeds or have numerous single fruits with single seeds, and that have small seeds that are easy to swallow and pass.

This book is quite logical in its layout and thus easy to use as the reference it is, but the conclusions the study reaches elucidate many more areas for further study and critical thought, as any good scientific project ought. It is an easy marriage of botany and zoology, and speaking from a botanical perspective, much more than satisfactory and a necessary reference for anyone studying plant-animal interactions.—*Tiana Franklin, Botanical Research Institute of Texas, Fort Worth, Texas 76102-4025, U.S.A.*

ADDITIONAL FAMILY ACRONYMS FOR VASCULAR PLANTS BASED ON APG III

Neil Snow

Herbarium Pacificum
Bishop Museum
1525 Bernice Street,
Honolulu, Hawai'i 96817, U.S.A.
neil.snow@bishopmuseum.org

ABSTRACT

Six additional 3-letter family acronyms are proposed for vascular plants.

RESUMEN

Se proponen acrónimos de tres letras para seis familias de plantas vasculares.

The recent publication of additional 3-letter family acronyms or abbreviations for families of vascular plants (Snow 2009) occurred before the author was aware of the additions and suggested changes that appeared in APG III (2009). The six acronyms are necessary given earlier omissions (e.g., Alford 2006) and the desire by certain curators to use other family names for which such acronyms are not yet available. The proposed acronyms are:

Anacampserotaceae (ACM)
Boweniaceae (BOW)
Gerrardinaceae (GRR)
Maundiaceae (MAU)
Montiaceae (MON)
Veronicaceae (VER)

Future authors of new families of vascular plants are strongly encouraged to propose new 3- and 4-letter acronyms (see Kiger & Reveal 2000, 2009) for each new family along with the family itself, so that future updates of the present type are unnecessary.

ACKNOWLEDGMENTS

I thank Kent Perkins (FLAS) and Dieter Wilken (SBBG) for their comments. As previously, the Colorado Native Plant Society has kindly agreed to post on-line the complete lists alphabetically by family and (separately) by 3-letter acronym (see: http://www.conps.org/pdf/Plant%20Keys/ACROS.pdf).

REFERENCES

Alford, M.H. 2006. Gerrardinaceae: a new family of African flowering plants unresolved among Brassicales, Huerteales, Malvales, and Sapindales. Taxon 55:959–964.

APG (Angiosperm Phylogeny Group). 2009. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. Bot. J. Linnean Soc. 161:105–121.

Kiger, R.W. and J.L. Reveal. 2000. A comprehensive scheme for standardized abbreviation of usable plant-family names and type-based suprafamilial names. Huntia 11:55–84.

Kiger, R.W. and J.L. Reveal. 2009. A comprehensive scheme for standardized abbreviation of usable plant-family names and type-based suprafamilial names. http://www.plantsystematics.org/reveal/pbio/fam/famabbr.html [Accessed 4 November 2009].

Snow, N. 2009 Twenty-eight new three-letter family acronyms for vascular plants (with comprehensive listings on-line). J. Bot. Res. Inst. Texas 3:273–277.

J. Bot. Res. Inst. Texas 3(2): 993. 2009

ANNOUNCEMENT

Applications for the 2010 Delzie Demaree Travel Award

The Delzie Demaree Travel Award provides financial support for graduate students to travel to the Annual Systematics Symposium held every year at the Missouri Botanical Gardens in St. Louis, Missouri. Typically one $300 award is granted per year, but value and number of awards may vary depending on availability of funds and number of total applicants. Applications for the 2010 Delzie Demaree Travel Award should include a letter from the applicant telling how symposium attendance will benefit his/her graduate work and a letter of recommendation sent by the major professor. Please send letters of application to: Dr. Donna M.E. Ware, P.O. Box 8795, Herbarium, Biology Department, The College of William and Mary, Williamsburg, VA 23185-8795, U.S.A. 1-757-221-2799; Email: ddmware@wm.edu. The period for receiving applications will end three weeks prior to the date of the symposium if a sufficient number of applications are in hand at that time. Anyone wishing to apply after that date should inquire whether applications are still being accepted before applying. The Systematics Symposium dates for 2010 are 8–9 October.

The Delzie Demaree Travel Award was established in 1988 honoring **Delzie Demaree** who attended 35 out of a possible 36 symposia before he died in 1987. Delzie Demaree was a frontier botanist, explorer, discoverer, and teacher. His teaching career as a botanist began in Arkansas at Hendrix College in 1922. He also taught botany at the University of Arkansas, Navajo Indian School, Yale School of Forestry, Arkansas A&M, and Arkansas State University at Jonesboro where he retired as professor emeritus in 1953. One of the things he enjoyed most as a botanist was assisting students with their field botany research.

Anyone interested in making a contribution to Delzie Demaree Endowment Fund, which supports the travel award, may make contributions by VISA or MasterCard or by a check, payable to Botanical Research Institute of Texas, to Barney Lipscomb, 500 E 4th Street, Fort Worth, TX 76102-4025, U.S.A. 1-817-332-7432; Email: barney@brit.org. Thank you.

The 2009 Delzie Demaree Award recipients: John Emerson, Mackenzie Taylor, Suman Neupane.

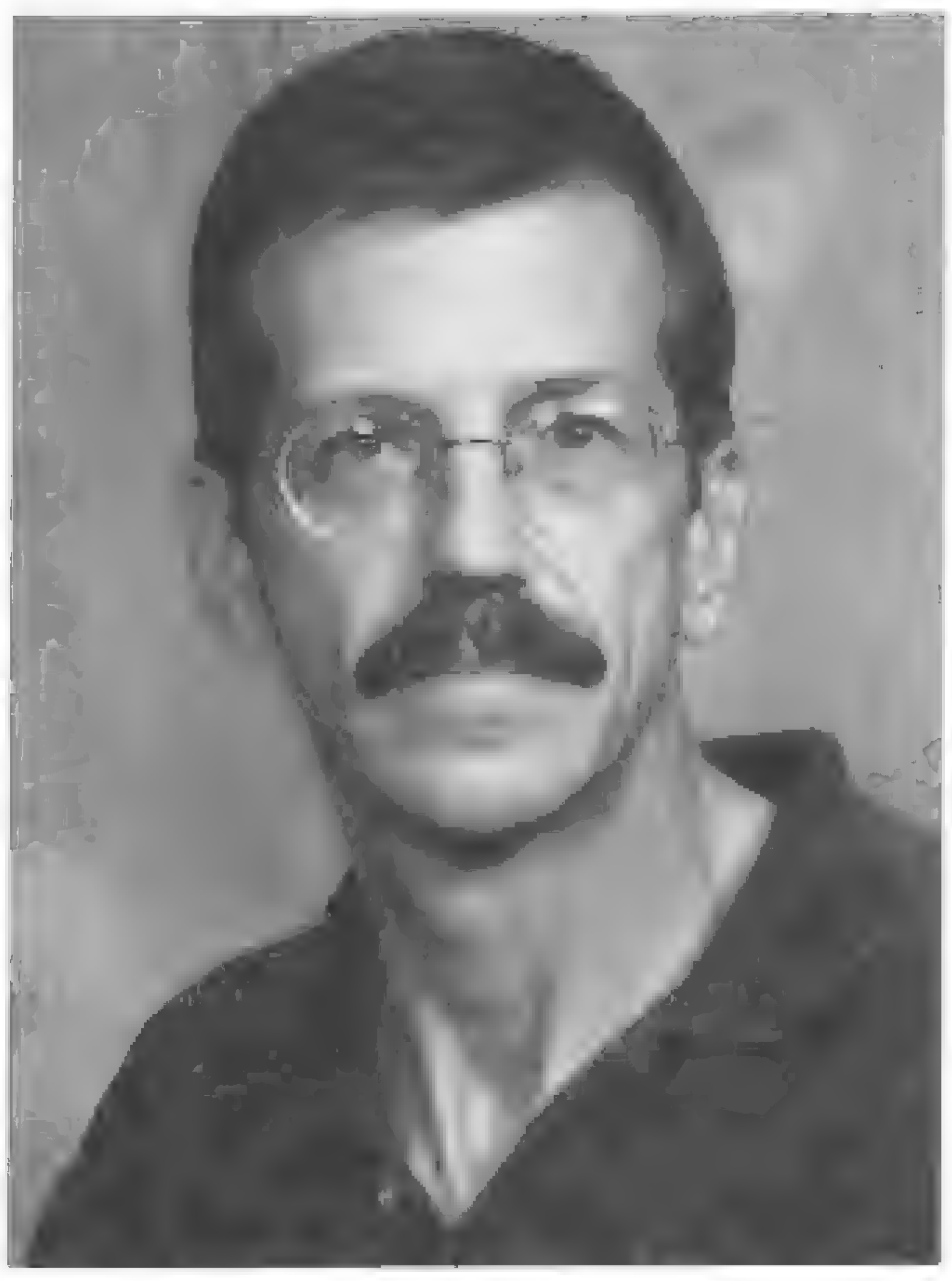
J. Bot. Res. Inst. Texas 3(2): 994. 2009

IN MEMORIAM

BRUCE DALE PARFITT, 7 NOVEMBER 1952–3 SEPTEMBER 2009

Neil A. Harriman

Biology Department
University of Wisconsin-Oshkosh
Oshkosh, Wisconsin 54901, U.S.A.
harriman@uwosh.edu



Courtesy, The University of Michigan-Flint

Botanist, biologist, birder Bruce Dale Parfitt of Johnson, Vermont, died at Vermont Respite House in Williston, 3 September 2009. He was 56. Bruce was born 7 November 1952 in Oshkosh, Wisconsin, the son of Dale and Joan (neé Barth) Parfitt. From age four during family vacations, he fished, hunted, and camped in Oconto County in the land of the jack pines and sweet ferns "up north." He graduated from Oshkosh High School in 1970, and earned a bachelor of science degree from the University of Wisconsin-Oshkosh in 1977. He earned his masters and doctoral degrees from Arizona State University in 1980 and 1991, where he was also herbarium curator and teaching associate. For both degrees, he worked closely with Professor Donald Pinkava, who was instrumental in encouraging Bruce's interest in cacti.

At the University of Michigan-Flint he was a valued faculty member for 14 years, chair of the biology department from 2004–2007, and director of the university's herbarium, whose collection grew in size and value under his care. He kept high standards, edited papers relentlessly, challenged assumptions, but lavished his time toward students' success in the classroom, in the lab, in the field, and in their personal lives. As a result, many became first—generation graduates who found confidence and success in biology—related careers or entered Master's and Ph.D. programs at top universities.

Prior to joining the faculty of UM-Flint, he was a research botanist for the Desert Botanical Garden in Phoenix, and a scientific editor of "Flora of North America" headquartered at the Missouri Botanical Garden. He was a significant contributor to the Ranunculaceae, volume 3, 1997, and the Cactaceae in volume 4, 2003. He also prepared *Opuntia* for the Jepson Manual, 1993. He authored some 40 papers in the literature, beginning with a paper on *Allenrolfea* (Chenopodiaceae) in Rhodora, 1977, while he was an undergraduate at UW-Oshkosh.

Among his friends, he was an avid birder, moose watcher, canoeist, Mr. Fix-it, and hunter and planter of trees. He was as tenacious in his friendships as in his opinions. He seemed to apply a scientific approach whether decorating Christmas cookies or designing birdhouses.

And since 1997, he came to love Vermont, first visiting, then buying a place and staying as often as he could at his "Mooseberry Camp" on the Lamoille River in Johnson.

It was while working as a field biologist in 1979 for the U.S. Bureau of Land Management—helicoptered in to hike the remote Hualapai Mountains and to collect, identify, and preserve rare species—that he discovered a new species, named by Barbara Ertter in 2009 as *Potentilla demotica*. It was also in the Hualapai that Bruce developed a blood vessel malformation that was impinging on his spinal column. An unfortunate reaction to diagnostic tests cost him the use of his legs. Undaunted, in 1980, he learned to walk with canes. Similarly, throughout his life he often took on projects of considerable magnitude—building a house, planting trees, restoring riverbanks, and the like.

In late July, 2009, Bruce and his mother invited my wife and me to lunch at an Oshkosh restaurant. Dur-

J. Bot. Res. Inst. Texas 3(2): 995 – 996. 2009

ing lunch, he told us that he had come to say good-bye. The doctors had exhausted their armamentarium of chemotherapies, and surgery would only delay the inevitable end. Bruce and I went that afternoon to watch the American White Pelicans at a tiny lake nearby; the species was not present in Wisconsin when Bruce was such an avid local birdwatcher. The pelican in myth and folklore represents loyalty and self-sacrifice, a most fitting compliment to Bruce Dale Parfitt.

Editor's Note.—This contribution also appears in *Flora of North America Newsletter* 23(2).

HOWARD L. CLARK, 1941–2009

Kate Clark, wife of Howard L. Clark (Quito, Ecuador), emailed me with sad news that Howard died suddenly on 27 August 2009. Howard was a friend and colleague always willing to help with reviewing manuscripts. "I always will be glad to review papers or anything else for the *exSida*, as I received many of the first issues as an undergraduate (student of John W. Thieret, then at Univ. SW Louisiana, Lafayette) for "free" after making a deal with Lloyd Shinners to trade my plant collections for *Sida*—I probably never sent enough to be adequate. My first botanical publication was in *Sida*. Yes, that was a few years ago, long before I moved to the amphiscian realm (as John Thieret phrased it)."

I contacted Howard on June 25, 2009, seeking a review of a manuscript submitted to *J. Bot. Res. Inst. Texas*. Of course Howard was more than willing to help and to give of his time ("exceptionally glad" were his words). The resulting correspondence was like rediscovering a close friend from the past. We had a good time catching up and reminiscing about our mutual friend John Thieret (his "professor, mentor, and friend"…and, I might add personally, my mentor and friend). We happily shared stories about Lloyd Shinners of whom neither one of us met in person. Our friend John Thieret worked closely with Lloyd and *Sida* from the 1960s to early 70s until Lloyd passed away in 1971. Howard said his old copies of *Sida* were safely stored in Atlanta; he even remembered Professor Joe Ewan's poem to Lloyd Shinners in response to the first issue of *Sida* (22 Nov 1962).

John W. Thieret (1926–2005) served as Howard's major professor for his master's degree in Biology at University of Southwestern Louisiana, Lafayette. Howard studied the Lemnaceae of Louisiana for his M.S., a project Howard started as an undergraduate. Howard and John published together in 1968 *The duckweeds [Lemnaceae] of Minnesota* (Michigan Bot. 7:67–76).

Over the last several years Howard had been living and working in Quito, Ecuador. He was working mostly as an ecological consultant ("increasingly, industrial stuff" as Howard put it), but his love was botany. He had set aside for me a copy of a recent botanical publication of his (a Venezuela florula) that he was most proud of.

Clark, H.[L.], R. Liesner, P.E. Berry, A. Fernandez, G. Aymard, and P. Maquirino. 2000. Catálogo anotado de la flora del área de San Carlos de Río Negro, Venezuela. Scientia Guaianae (Caracas) 11:101–333 + 21 color photos. (103 illustrations by B. Manara).

"For 4.5 years ('79–'81), we (my wife is an ichthyologist, but also a good botanist who worked for Joe Ewan for a year at the Tulane herbarium) lived in San Carlos de Rio Negro, Venezuela, where the soil had a lot of outwash quartz sands from the tepuis and from the Shield, and the flora had a lot of connection to the strange stuff above us on the shield and tepuis. San Carlos is across the Rio Negro from Colombia, about 15 km south of the Rio Casiquiare, and about 60 km north of Brasil. It took many years, but I finally published a florula/checklist (in a pub. more obscure than *Sida*) for there." This florula is surely a testament to the botanist Howard L. Clark.

I'm so sorry and my heart is saddened to lose a friend and colleague. Thanks, Howard, for all of your contributions to science!—*Barney L. Lipscomb, Botanical Research institute of Texas, Fort Worth, Texas 76102-4025, U.S.A.*

Reviewers:
Volume 3 (2009)

188 reviewers: several individuals reviewed more than one manuscript.
Thank you for supporting *Journal of the Botanical Research Institute of Texas.*

Alford, Mac H.
Allen, Charles M.
Allred, Kelly W.
Anderson, Gregory J.
Anderson, Loran C.
Aymard, Gerardo C.

Barrie, Fred R.
Bayrd, Venice
Bean, A.R.
Bell, Dennis
Block, Timothy
Bogler, David J.
Bohs, Lynn J.
Brown, Elizabeth
Brown, Larry E.
Bryson, Charles T.
Butler, Ivan Maureira
Butterworth, Charles A.

Carr, Gerald D.
Carr, William R.
Carranza-Pérez, Miguel A.
Carter, Richard
Cerros-Tlatilpa, Rosa
Chambers, Kenton L.
Chandler, Gregory T.
Chautems, Alain
Christensen, Knud Ib
Clancy, Keith E.
Clark, Howard L.
Clark, John L.
Clarke, David
Colín, Rafael Torres
Cowie, Ian D.
Cox, George W.
Crespo, Manuel B.
Cusick, Allison W.

Darbyshire, Stephen J.
Daskin, Ruziye
Davenport, L.J.
Davison, Paul
Dehgan, Bijan
Delprete, Piero
Denham, Miriam L.
Dessein, Steven
Diggs, George
DiTomaso, Joseph
Doust, Andrew
Dressler, Stefan
Dusen, Olcay Dinc
Dutton, Bryan E.

Edwards, Christine E.
Eggli, Urs
Eliasson, Uno
Endress, Mary E.
Estes, James
Estrada-Castillón, Eduardo
Ezcurra, Cecilia

Ferguson, Carolyn J.
Filip, Greg
Foti, Thomas
Frodin, David G.
Frye, Christopher T.

Gandhi, Kanchi
Gandhi, Thomas
Gelli de Faria, Ana Paula
Gepts, Paul
Ghahremaninejad, Farrokh
Gomez-Sanchez, Maricela
González-Elizondo, M. Socorro
Guaglianone, Encarnación R.
Gutierrez, Raul

Hansen, Bruce F.
Hartman, Ronald L.
Haston, Elspeth
Hatch, Stephan L.
Henrickson, James
Herrera Arrieta, Yolanda
Hiepko, Paul
Hill, L.M.
Hill, Steven R.
Hoagland, Bruce
Hogan, Tim
Holmes, Walter C.

Judd, Walter S.

Kaul, Robert B.
Keeley, Jon
Keil, David J.
Kelly, Lawrence M.
Keßler, P.J.A.
Kirkbride, Jr., Joseph H.
Knapp, Sandra
Krosnick, Shawn
Kumar, E.S. Santhosh
Kumar, Muktesh
Lammers, Thomas G.
Landrum, Leslie R.
Larson, Gary E.
Legler, Ben
Lemke, David E.
Levin, Rachel A.
Lipscomb, Barney
Lock, J. Michael
Lombardi, Julio A.
Lorence, David
Lorence, Lucas

MacDougal, John
MacRoberts, Barbara R.
MacRoberts, Michael H.
Manickam, V.S.
Marhold, Karol
Mata, Juan L.
McCauley, Ross A.
Methven, Andrew
Mora, Marcela
Morawetz, Jeffery
Morgan, David
Morton, Cynthia M.
Mueller, Gregory M.
Müller, J.

Naczi, Robert F.C.
Nath, Virendra
Nesom, Guy L.
Nilsson, Henrik

Olmstead, Richard G.
Oteng-Yeboah, Alfred

Pandit, M.K.
Panero, Jose L.
Patterson, Robert W.
Pennington, Terry
Penskar, Michael R.
Perez-Cortez, Silvia
Perkins, Kent D.
Pilz, George E.
Plunkett, Gregory M.
Poole, Jackie
Post, Angela R.
Powell, A. Michael

Ramírez-Morillo, Ivón M.
Randle, Christopher P.
Ranker, Tom A.
Reed, Monique D.
Reid, Christopher S.
Reveal, James L.
Robertson, Kenneth R.
Robinson, Harold
Rolfsmeier, Steven B.
Rosen, David

Saarela, Jeffery M.
Sadle, Jimi
Salazar, Jackeline
Sanchez-Ken, J. Gabriel
Sanjappa, M.
Sano, Paulo T.
Santelises, Remedios Aguilar
Scharpf, Robert
Schilling, Edward E.
Schneider, Angelo Alberto
Schutzman, Bart
Serna, Adolfo Espejo
Shultz, Leila M.
Sinou, Carole
Sivinski, Robert C.
Smith, Latimore
Snow, Neil
Soriano, Sara Fuentes
Spaulding, Dan
Spooner, David M.
Ståhl, Bertil

Taylor, Alberto Sidney
Taylor, Charlotte M.
Telfair II, Ray
Terrell, Edward E.
Tiehm, Arnold
Tillett, Stephen S.
Tucker, Arthur O.

Urban, Lillis

Valdés-Reyna, Jesús
Vanderpool, Staria S.

Wada, Eric
Wagner, Warren L.
Waines, J.G.
Waitt, Damon
Ward, Daniel B.
Weber, William A.
Weedon, Ronald R.
Wege, Juliet
Wiens, Del
Wipff, J.
Wunderlin, Richard P.

J. Bot. Res. Inst. Texas 3(2): 997 – 1008. 2009

INDEX TO 111 TITLES WITH 175 AUTHORS:
VOLUME 3 (2009)

We know you have a choice. Thank you for choosing and supporting *Journal of the Botanical Research Institute of Texas.*

A classification of geographic elements and analysis of the flora of Big Bend region of Texas by Anna Saghatelyan—**3(1):**407

A floristic inventory of Marco Island (Collier County), Florida by G.J. Wilder and B.J. Roche—**3(2):**873

A new cliff-dwelling species of **Zamia** (Zamiaceae) from Belize by Michael Calonje—**3(1):**23

A new combination in North American **Tephrosia** (Fabaceae) by Guy L. Nesom and James L. Zarucchi—**3(1):**157

A new genus, **Mexotis,** for five Mexican species of Hedyotideae (Rubiaceae) by Edward E. Terrell and Harold Robinson—**3(1):**59

A new narrowly endemic species of **Dirca** (Thymelaeaceae) from Kansas and Arkansas, with a phylogenetic overview and taxonomic synopsis of the genus by Aaron J. Floden, Mark H. Mayfield, and Carolyn J. Ferguson—**3(2):**485

A new species of **Schefflera** (Araliaceae) from the Venezuelan Andes by L.J. Dorr and Basil Stergios—**3(2):**605

A new species of **Zamia** (Zamiaceae) from the Maya Mountains of Belize by Michael Calonje, Jan Meerman, Patrick Griffith, and Geoffrey Hoese—**3(1):**31

A phylogeny of **Arctostaphylos** (Ericaceae) inferred from nuclear ribosomal ITS sequences by Gregory A. Wahlert, V. Thomas Parker, and Michael C. Vasey—**3(2):**673

A recombination for varieties of **Anticlea elegans** (Melanthiaceae) by Wendy B. Zomlefer and Walter S. Judd—**3(1):**159

A revision to the vascular flora of Calcasieu Parish, Louisiana by Ray Neyland—**3(1):**375

Additional family acronyms for vascular plants based on APG III by Neil Snow—**3(2):**993

Additional morphological measurements of **Arceuthobium siskiyouense** and **A. monticola** (Viscaceae) by Robert L. Mathiasen and Carolyn M. Daugherty—**3(2):**741

Additional observations about **Phaseolus rotundatus** (Fabaceae), an endemic bean species from western Mexico by Jesús Salcedo C., Rogelio Lépiz I., Nora Castañeda A., César Ocampo N., and Daniel G. Debouck—**3(2):**751

Additions and emendations to the vascular flora of Caddo Parish, Louisiana by Barbara R. MacRoberts, Michael H. MacRoberts, Christopher S. Reid, and Patricia L. Faulkner—**3(1):**379

Again: taxonomy of yellow-flowered caulescent **Oxalis** (Oxalidaceae) in eastern North America by Guy L. Nesom—**3(2):**727

Amorpha confusa, a new name for an old **Amorpha** (Fabaceae: Amorpheae) by Shannon C.K. Straub, Bruce A. Sorrie, and Alan S. Weakley—**3(1):**151

An investigation of morphological evidence supports the resurrection of **Pyrrocoma scaberula** (Asteraceae: Astereae) by Curtis R. Björk and Mark Darrach—**3(1):**231

An overview of the **Diospyros campechiana** complex (Ebenaceae) and description of three new species by Mitchell C. Provance and Andrew C. Sanders—**3(1):**85

Anatomía de la epidermis foliar en las especies Mexicanas del género **Muhlenbergia** (Poaceae) by Octavio Rosales Carrillo and Yolanda Herrera Arrieta—**3(1):**285

Annotated checklist of the vascular flora of the Menard Creek Corridor Unit of the Big Thicket National Preserve, Polk, Liberty, and Hardin counties, Texas by Larry E. Brown, Barbara R. MacRoberts, Michael H. MacRoberts, and Warren W. Pruess—**3(1):**443

Annotated list of Maryland grasses (Poaceae) by Edward E. Terrell and Paul M. Peterson—**3(2):**905

Assessment of invasiveness and ecological impact in non-native species of Texas by Guy L. Nesom—**3(2):**971

Berberis repens (Berberidaceae) new again to the flora of Pennsylvania by Jerry G. Chmielewski—**3(2):**963

Bouteloua curtipendula var. **tenuis** (Poaceae: Cynodonteae), new to Texas and the United States and a key to **B. curtipendula** varieties by Stephan L. Hatch, Maria Andrea Tomas, and Steven R. Archer—**3(2):**965

Bristlecone pine dwarf mistletoe: **Arceuthobium microcarpum** subsp. **aristatae** (Viscaceae), a new subspecies of western spruce dwarf mistletoe from northern Arizona by Jared M. Scott and Robert L. Mathiasen—**3(1):**13

Bruce Dale Parfitt, 7 November 1952–53 September 2009 by Neil A. Harriman—**3(2):**995

Capsicophysalis: a new genus of Solanaceae (Physaleae) from Mexico and Central America by John E. Averett and Mahinda Martínez—**3(1):**71

Castilleja angustifolia var. **dubia** (Scrophulariaceae), a new record for South Dakota by Grace Kostel and Lynn Hetlet—**3(1):**391

Checklist of the plants of the Guiana Shield 1. An update to the Angiosperms by Christian Feuillet—**3(2):**799

Chromosome numbers of miscellaneous angiosperm taxa by Marc Baker, Jon Rebman, Bruce Parfitt, Donald Pinkava, Charlotte Christy, Andrew Salywon, Raul Puente-Martinez, Allan Zimmerman, and J. Hugo Cota—**3(1):**279

Clarification of the typification of Michaux names in eastern North American **Vitis** (Vitaceae) by Connie Fisk and Alexander Krings—**3(2):**739

Clarifications concerning the nomenclature and taxonomy of **Oxypolis ternata** (Apiaceae) by Mary Ann E. Feist—**3(2):**661

Cryptostegia grandiflora (Apocynaceae: Asclepiadoideae), a new non-native weed for Texas by Thomas F. Patterson and Guy L. Nesom—**3(1):**461

Cyperus pilosus (Cyperaceae) new to the flora of Texas by Richard Carter, Charles M. Allen, Patricia Lewis, and David P. Lewis—**3(1):**457

Diplycosia indica (Ericaceae): a new species and a new generic record for India by M.R. Debta and H.J. Chowdhery—**3(1):**147

Discovery of a Lewis and Clark grass collection, **Poa secunda** (Poaceae) sensu lato, at the herbarium of the Royal Botanic

Gardens, Kew by Jacques Cayouette, James L. Reveal, and Gary E. Moulton—**3(2):**763

Diversidad y distribución de las gramíneas (Poaceae) en el estado de Zacatecas by Yolanda Herrera Arrieta y Armando Cortés Ortiz—**3(2):**775

Erigeron bellioides (Asteraceae), new to Florida and the continental United States by Randy L. Mears—**3(2):**869

Eriogonum cedrorum (Polygonaceae: Eriogonoideae), a new species from northwestern California by James L. Reveal and Roger Raiche—**3(2):**479

Eriogonum villosissimum (Polygonaceae: Eriogonoideae), a new species endemic to Acker Rock, Oregon by James L. Reveal, Dana York, and Richard Helliwell—**3(2):**639

Estudios en las Apocynaceae neotropicales XXXVII: monografía del género **Rhabdadenia** (Apocynoideae: Echiteae) by J. Francisco Morales—**3(2):**541

Estudios en las Apocynaceae neotropicales XXXVIII: tres nuevas especies de **Mandevilla** (Apocynoideae: Mesechiteae) para Colombia y Venezuela by J. Francisco Morales—**3(2):**565

Festuca aloha and **F. molokaiensis** (Poaceae: Loliinae), two new species from Hawai'i by Pilar Catalán, Robert J. Soreng, and Paul M. Peterson—**3(1):**51

Five new species of Myrtaceae from Ecuador by Maria Lúcia Kawasaki and Bruce K. Holst—**3(1):**123

Floristic composition, abundance, and distribution pattern of woody plants in a tropical savanna in northern Ghana by Alex Asase, Patrick K. Ekpe, and John Y. Amponsah—**3(1):**309

Floristic studies in north central New Mexico, U.S.A. The Tusas Mountains and the Jemez Mountains by Brian Reif, Jill Larson, Brian F. Jacobs, B.E. Nelson, and Ronald L. Hartman—**3(2):**921

Floristics of upland shortleaf pine/oak-hickory forest in northwestern Louisiana by Barbara R. MacRoberts and Michael H. MacRoberts—**3(1):**367

Folia taxonomica 12. **Paradrymonia** (Gesneriaceae: Episcieae) from the Guiana Shield: **P. maguirei,** a new species from Amazonas, and distribution and floral morphology of **P. maculata** by Christian Feuillet—**3(1):**133

Folia taxonomica 13. **Passiflora curva** (Passifloraceae), a new species from French Guiana in subgenus **Passiflora** supersection **Coccinea** by Christian Feuillet—**3(2):**577

Folia taxonomica 14. Notes on **Passiflora** supersection **Coccinea** (Passifloraceae) from the Guiana Shield by Christian Feuillet and John Vanderplank—**3(2):**581

Folia taxonomica 15. Five new species of **Paradrymonia** subgenus **Paradrymonia** (Gesneriaceae: Episcieae) from the Venezuelan Guayana by Christian Feuillet—**3(2):**583

Folia taxonomica 16. **Dilkea** (Passifloraceae) 1. **Epkia,** a new subgenus and five new species from western Amazonia and the Guianas by Christian Feuillet—**3(2):**593

Glyceria declinata (Poaceae) new to the flora of Texas by Charles M. Allen, Patricia Lewis, and David P. Lewis—**3(1):**393

Howard L. Clark, 1941–2009 by Barney L. Lipscomb—**3(2):**996

Infrageneric taxonomy of **Astrophytum** (Cactaceae), with remarks on the status of **Digitostigma** by Richard R. Montanucci—**3(1):**251

Introduced lesser celandine (**Ranunculus ficaria,** Ranunculaceae) and its putative subspecies in the United States: a morphometric analysis by Angela R. Post, Alexander Krings, Wade A. Wall, and Joseph C. Neal—**3(1):**193

Learning about other species: an updated component of a liberal arts education by Guy L. Nesom and Alan S. Weakley—**3(1):**1

Lectotypification of **Cardamine flexuosa** (Brassicaceae) by Angela R. Post, Alexander Krings, Qui-Yun (Jenny) Xiang, Bryon R. Sosinski, and Joseph C. Neal—**3(1):**227

Lipocarpha micrantha (Cyperaceae), nueva cita para la flora de Argentina: micromorfología del fruto by Priscila R. Van de Velde y M. Gabriela López—**3(2):**793

Medicago rigidula and **M. truncatula** (Fabaceae): new to the California flora by Richard E. Riefner, Jr. and Ernest Small—**3(1):**323

Mentha suaveolens and **M. ×rotundifolia** in North Carolina: a clarification of distribution and taxonomic identity by Michael W. Denslow and Derick B. Poindexter—**3(1):**383

Miscellaneous typifications, one new series, and one new varietal combination in **Crataegus** (Rosaceae) by J.B. Phipps—**3(1):**239

Muhlenbergia tarahumara (Poaceae: Chloridoideae: Cynodonteae: Muhlenbergiinae), a new species from Chihuahua, Mexico by Paul M. Peterson and J. Travis Columbus—**3(2):**527

Mycological literature on Texas fleshy Basidiomycota, two new combinations, and new fungal records for Texas by David P. Lewis and Clark L. Ovrebo—**3(1):**257

Neotypification of **Artemisia carruthii** (Asteraceae: Anthemideae) by Caleb A. Morse and James L. Reveal—**3(2):**667

New and noteworthy plants from Florida by John M. Kunzer, Richard P. Wunderlin, Loran C. Anderson, and James R. Burkhalter—**3(1):**331

New species of **Baccharis** (Asteraceae: Astereae) from Rio de Janeiro state, southeastern Brazil by G. Heiden, J.F.A. Baumgratz, and R.L. Esteves—**3(1):**139

New species of **Eugenia** (Myrtaceae) from Ecuador by Maria Lúcia Kawasaki and Bruce K. Holst—**3(2):**609

New state records of vascular plants for the Southern Rocky Mountain region by Pamela F. Smith, Donald L. Hazlett, and Neil Snow—**3(1):**317

Nomenclatural innovations in **Phlox** (Polemoniaceae), with updated circumscription of **P. caespitosa, P. douglasii, P. missoulensis,** and **P. richardsonii** by James H. Locklear—**3(2):**645

Notes on the taxonomic history of two rare species of **Begonia** (Begoniaceae) from Sikkim Himalaya and their conservation by D.C. Nautiyal, S.K. Sharma, and M.K. Pandit—**3(2):**823

Notes on the taxonomic history, rediscovery and conservation status of two endangered species of **Ceropegia** (Asclepiadaceae) from Sikkim Himalaya by D.C. Nautiyal, S.K. Sharma, and M.K. Pandit—**3(2):**815

Novedades y notas misceláneas en las Bromeliaceae de Mesoamérica by J. Francisco Morales—**3(1):**113

Orobanche riparia (Orobanchaceae), a new species from the American Midwest by L. Turner Collins, Alison E.L. Colwell, and George Yatskievych—**3(1):**3

Pinus pinceana (Pinaceae), nuevo registro para el estado de Nuevo León, México by Susana Favela Lara, Carlos G. Velazco Macías y Glafiro J. Alanís Flores—**3(2):**771
Polygala cymosa (Polygonaceae) new to Texas by Michelle Pollard, Jason R. Singhurst, and Walter C. Holmes—**3(2):**969
Preliminary insights into the phylogeny and speciation of **Scalesia** (Asteraceae), Galápagos Islands by Jeremy D. Blaschke and Roger W. Sanders—**3(1):**177
Primer reporte de **Cystopteris reevesiana** (Aspleniaceae) para México by José A. Villarreal-Q. and Celestino Flores-L.—**3(1):**307
Pyracantha koidzumii (Rosaceae) new to the Arkansas flora by Brett E. Serviss—**3(1):**319

Revisión de las especies sudamericanas del género **Schwartzia** (Marcgraviaceae: complejo **Norantea**) by Diego Giraldo-Cañas—**3(2):**691
Revision of **Bauhinia** subgenus **Bauhinia** section **Pauletia** series **Ariaria** (Cercideae: Caesalpinioideae: Fabaceae) by Richard P. Wunderlin—**3(2):**629
Revision of **Bauhinia** subgenus **Phanera** section **Schnella** (Cercideae: Caesalpinioideae: Fabaceae) by Richard P. Wunderlin and Richard M. Eilers—**3(2):**619

Sagina caespitosa (Alsinaceae) in Colorado, U.S.A. by A.E. Porsild†, W.A. Weber, R.C. Wittmann—**3(2):**867
Salvinia minima and **S. oblongifolia** (Salviniaceae) new to California, with notes on the **S. auriculata** complex by Richard E. Riefner, Jr. and Alan R. Smith—**3(2):**855
Status assessment of **Eleocharis wolfii** (Cyperaceae) in the United States by Paul M. McKenzie, C. Theo Witsell, Loy R. Phillippe, Christopher S. Reid, Michael A. Homoya, Steven B. Rolfsmeier, and Caleb A. Morse—**3(2):**831
Stenaria sanchezii (Rubiaceae), a new and endangered species from Sonora, Mexico by David H. Lorence—**3(2):**521
Studies of neotropical Compositae–II. A new combination in **Chromolaena** (Eupatorieae) by John F. Pruski—**3(2):**573
Synopsis of **Gonolobus** s.s. (Apocynaceae: Asclepiadoideae) in Trinidad and Tobago by Alexander Krings—**3(1):**77

Taxonomic overview of **Eurybia** sect. **Herrickia** (Asteraceae: Astereae) by Guy L. Nesom—**3(1):**161
The phylogeny of **Selenia** (Brassicaceae) inferred from chloroplast and nuclear sequence data by James B. Beck—**3(1):**169
The reinstatement of **Beautempsia** (Capparaceae) and a key to the genera of neotropical Capparaceae with variously stellate or peltate indumenta by Xavier Cornejo and Hugh H. Iltis—**3(2):**683
The types of **Astragalus** section **Diphysi** (Fabaceae), a complex endemic to Western North America, Part I: lectotypifications, epitypifications, and new combinations of several taxa by J. Andrew Alexander—**3(1):**211
The typification of **Crotalaria rotundifolia** and **Crotalaria maritima** (Fabaceae) by Daniel B. Ward—**3(1):**219
Three new species of **Solanum** section **Herpystichum** (Solanaceae) from Ecuador by Eric J. Tepe and Lynn Bohs—**3(2):**511
Thymelaea passerina (Thymelaeaceae) in South Dakota by Grace Kostel—**3(2):**901
Tournefortia hirsutissima (Boraginaceae) new to the flora of Texas by Alfred Richardson and W. Ken King—**3(1):**465
by
Twenty-eight new three-letter family acronyms for vascular plants (with comprehensive listings on-line) by Neil Snow—**3(1):**273
Two new combinations in **Tryphane** (Alsinaceae) by W.A. Weber and R.C. Wittmann—**3(2):**501
Two new species of **Solanum** from Ecuador and new combinations in **Solanum** section **Pachyphylla** (Solanaceae) by Stephen R. Stern and Lynn Bohs—**3(2):**503

Una nueva especie y notas misceláneas en el género **Oreopanax** (Araliaceae) en Centro América by J. Francisco Morales and Alvaro Idárraga—**3(1):**117
Una nueva especie y novedades nomenclaturales en el género **Meliosma** (Sabiaceae) by J. Francisco Morales—**3(2):**535

Validation of the name **Symplocos pentandra** (Symplocaceae) by João Luiz M. Aranha Filho, Peter W. Fritsch, Frank Almeda, and Angela B. Martins—**3(2):**659
Vascular flora of a saline prairie in Winn Parish, Louisiana by Barbara R. MacRoberts, Michael H. MacRoberts, Christopher S. Reid, and Patricia L. Faulkner—**3(1):**349
Vascular flora of Churchill Ranch, Sarasota County, Florida by Alan R. Franck and Richard P. Wunderlin—**3(1):**339
Vascular flora of Morse Clay prairies in northwestern Louisiana by Barbara R. MacRoberts, Michael H. MacRoberts, Christopher S. Reid, and Patricia L. Faulkner—**3(1):**355
Vascular plant species richness of the Big Thicket, East Texas by Michael H. MacRoberts and Barbara R. MacRoberts—**3(1):**401
Vegetation areas of Texas: concept and commentary by Ray C. Telfair II—**3(1):**395

What is **Ranunculus gelidus** (Ranunculaceae)? by Alan T. Whittemore—**3(1):**245
What is **Zamia prasina** (Zamiaceae: Cycadales)? by Michael Calonje and Jan Meerman—**3(1):**43

Xyris spathifolia (Xyridaceae), a new xyrid from the Ketona Dolomite-Limestone glades of Alabama by Robert Kral and J. Mincy Moffett, Jr.—**3(2):**469

INDEX OF 175 AUTHORS:
VOLUME 3 (2009)

Thank you for choosing *Journal of the Botanical Research Institute of Texas*

Alexander, J. Andrew—**3(1):**211
Allen, Charles M.—**3(1):**393, 457
Almeda, Frank—**3(2):**659
Amponsah, John Y.—**3(1):**309
Anderson, Loran C.—**3(1):**331
Archer, Steven R.—**3(2):**965
Arrieta, Yolanda Herrera—**3(1):**285; **3(2):**775
Asase, Alex—**3(1):**309
Averett, John E.—**3(1):**71

Baker, Marc—**3(1):**279
Baumgratz, J.F.A.—**3(1):**139
Beck, James B.—**3(1):**169
Björk, Curtis R.—**3(1):**231
Blaschke, Jeremy D.—**3(1):**177
Bohs, Lynn—**3(2):**503, 511
Brown, Larry E.—**3(1):**443
Burkhalter, James R.—**3(1):**331

Calonje, Michael—**3(1):**23, 31, 43
Carrillo, Octavio Rosales—**3(1):**285
Carter, Richard—**3(1):**457
Castañeda A., Nora—**3(2):**751
Catalán, Pilar—**3(1):**51
Cayouette, Jacques—**3(2):**763
Chmielewski, Jerry G.—**3(2):**963
Chowdhery, H.J.—**3(1):**147
Christy, Charlotte—**3(1):**279
Collins, L. Turner—**3(1):**3
Columbus, J. Travis—**3(2):**527
Colwell, Alison E.L.—**3(1):**3
Cornejo, Xavier—**3(2):**683
Cota, J. Hugo—**3(1):**279

Darrach, Mark—**3(1):**231
Daugherty, Carolyn M.—**3(2):**741
Debouck, Daniel G.—**3(2):**751
Debta, M.R.—**3(1):**147
Denslow, Michael W.—**3(1):**383
Dorr, L.J.—**3(2):**605

Eilers, Richard M.—**3(2):**619
Ekpe, Patrick K.—**3(1):**309
Esteves, R.L.—**3(1):**139

Faulkner, Patricia L.—**3(1):**349, 355, 379
Feist, Mary Ann E.—**3(2):**661
Ferguson, Carolyn J.—**3(2):**485
Feuillet, Christian—**3(1):**133; **3(2):**577, 581, 583, 593, 799
Filho, João Luiz M. Aranha—**3(2):**659
Fisk, Connie—**3(2):**739
Floden, Aaron J.—**3(2):**485
Flores, Glafiro J. Alanís—**3(2):**771
Flores-L., Celestino—**3(1):**307
Franck, Alan R.—**3(1):**339
Fritsch, Peter W.—**3(2):**659

Giraldo-Cañas, Diego—**3(2):**691
Griffith, Patrick—**3(1):**31

Harriman, Neil A.—**3(2):**995
Hartman, Ronald L.—**3(2):**921
Hatch, Stephan L.—**3(2):**965
Hazlett, Donald L.—**3(1):**317
Heiden, G.—**3(1):**139
Helliwell, Richard—**3(2):**639
Hetlet, Lynn—**3(1):**391
Hoese, Geoffrey—**3(1):**31
Holmes, Walter C.—**3(2):**969
Holst, Bruce K.—**3(1):**123; **3(2):**609
Homoya, Michael A.—**3(2):**831

Idárraga, Alvaro—**3(1):**117
Iltis, Hugh H.—**3(2):**683

Jacobs, Brian F.—**3(2):**921
Judd, Walter S.—**3(1):**159

Kawasaki, Maria Lúcia—**3(1):**123; **3(2):**609
King, W. Ken—**3(1):**465
Kostel, Grace—**3(1):**391; **3(2):**901
Kral, Robert—**3(2):**469
Krings, Alexander—**3(1):**77, 193, 227; **3(2):**739
Kunzer, John M.—**3(1):**331

Lara, Susana Favela—**3(2):**771
Larson, Jill—**3(2):**921
Lépiz I., Rogelio—**3(2):**751
Lewis, David P.—**3(1):**257, 393, 457
Lewis, Patricia—**3(1):**393, 457
Lipscomb, Barney L.—**3(2):**996
Locklear, James H.—**3(2):**645
López, M. Gabriela—**3(2):**793
Lorence, David H.—**3(2):**521

Macías, Carlos G. Velazco—**3(2):**771
MacRoberts, Barbara R.—**3(1):**349, 355, 367, 379, 401, 443
MacRoberts, Michael H.—**3(1):**349, 355, 367, 379, 401, 443
Martínez, Mahinda—**3(1):**71
Martins, Angela B.—**3(2):**659
Mathiasen, Robert L.—**3(1):**13; **3(2):**741
Mayfield, Mark H.—**3(2):**485
McKenzie, Paul M.—**3(2):**831
Mears, Randy L.—**3(2):**869
Meerman, Jan—**3(1):**31, 43
Moffett, Jr., J. Mincy—**3(2):**469
Montanucci, Richard R.—**3(1):**251
Morales, J. Francisco—**3(1):**113, 117; **3(2):**535, 541, 565
Morse, Caleb A.—**3(2):**667, 831
Moulton, Gary E.—**3(2):**763

Nautiyal, D.C.—**3(2):**815, 823
Neal, Joseph C.—**3(1):**193, 227
Nelson, B.E.—**3(2):**921
Nesom, Guy L.—**3(1):**1, 157, 161, 461; **3(2):**727, 971
Neyland, Ray—**3(1):**375

Ocampo N., César—**3(2):**751
Ortiz, Armando Cortés—**3(2):**775
Ovrebo, Clark L.—**3(1):**257

Pandit, M.K.—**3(2):**815, 823
Parfitt, Bruce—**3(1):**279
Parker, V. Thomas—**3(2):**673
Patterson, Thomas F.—**3(1):**461
Peterson, Paul M.—**3(1):**51; **3(2):**527, 905
Phillippe, Loy R.—**3(2):**831
Phipps, J.B.—**3(1):**239
Pinkava, Donald—**3(1):**279
Poindexter, Derick B.—**3(1):**383
Pollard, Michelle—**3(2):**969
Porsild, A.E.—**3(2):**867
Post, Angela R.—**3(1):**193, 227
Provance, Mitchell C.—**3(1):**85
Pruess, Warren W.—**3(1):**443
Pruski, John F.—**3(2):**573
Puente-Martinez, Raul—**3(1):**279

Raiche, Roger—**3(2):**479
Rebman, Jon—**3(1):**279
Reid, Christopher S.—**3(1):**349, 355, 379; **3(2):**831
Reif, Brian—**3(2):**921
Reveal, James L.—**3(2):**479, 639, 667, 763
Richardson, Alfred—**3(1):**465
Riefner Jr., Richard E.—**3(1):**323; **3(2):**855
Robinson, Harold—**3(1):**59
Roche, B.J.—**3(2):**873
Rolfsmeier, Steven B.—**3(2):**831

Saghatelyan, Anna—**3(1):**407
Salcedo C., Jesús—**3(2):**751
Salywon, Andrew—**3(1):**279
Sanders, Andrew C.—**3(1):**85
Sanders, Roger W.—**3(1):**177
Scott, Jared M.—**3(1):**13
Serviss, Brett E.—**3(1):**319
Sharma, S.K.—**3(2):**815, 823
Singhurst, Jason R.—**3(2):**969
Small, Ernest—**3(1):**323
Smith, Alan R.—**3(2):**855
Smith, Pamela F.—**3(1):**317
Snow, Neil—**3(1):**273, 317; **3(2):**993
Soreng, Robert J.—**3(1):**51
Sorrie, Bruce A.—**3(1):**151
Sosinski, Bryon R.—**3(1):**227
Stergios, Basil—**3(2):**605
Stern, Stephen R.—**3(2):**503
Straub, Shannon C.K.—**3(1):**151

Telfair II, Ray C.—**3(1):**395
Tepe, Eric J.—**3(2):**511
Terrell, Edward E.—**3(1):**59; **3(2):**905
Tomas, Maria Andrea—**3(2):**965

Van de Velde, Priscila R.—**3(2):**793
Vanderplank, John—**3(2):**581
Vasey, Michael C.—**3(2):**673
Villarreal-Q., José A.—**3(1):**307

Wahlert, Gregory A.—**3(2):**673
Wall, Wade A.—**3(1):**193
Ward, Daniel B.—**3(1):**219

Weakley, Alan S.—**3(1):**1, 151
Weber, W.A.—**3(2):**501, 867
Whittemore, Alan T.—**3(1):**245
Wilder, G.J.—**3(2):**873
Witsell, C. Theo—**3(2):**831
Wittmann, R.C.—**3(2):**501, 867
Wunderlin, Richard P.—**3(1):**331, 339; **3(2):**619, 629

Xiang, Qui-Yun (Jenny)—**3(1):**227

Yatskievych, George—**3(1):**3
York, Dana—**3(2):**639

Zarucchi, James L.—**3(1):**157
Zimmerman, Allan—**3(1):**279
Zomlefer, Wendy B.—**3(1):**159

BOTANICAL NAMES AND SUBJECT INDEX:

Volume 3 (2009)
New names (95) in **bold face**

Acronyms, family—**3(1):**273; **3(2):**993
Aechmea
  angustifolia—**3(1):**113
  penduliflora—**3(1):**113
Aegopogon cenchroides—**3(2):**527
Aegopogon clade—**3(2):**527
Africa—**3(1):**309
Aira brevifolia—**3(2):**763
Alabama, USA—**3(2):**469
Alsinaceae—**3(2):**501, 867
Amaranthus californicus—**3(1):**317
Amazonas, Venezuela—**3(1):**133; **3(2):**583
Amazonia—**3(2):**593
Amorpha
  confusa—**3(1):**151, 154
  georgiana—**3(1):**151
    var. confusa—**3(1):**151
Amorpheae (Fabaceae)—**3(1):**151
Andes—**3(2):**605
Angiosperm Phylogeny Group—**3(2):**993
Angiosperms—**3(1):**279
Anthemideae (Asteraceae)—**3(2):**667
Anticlea elegans var. **glaucus**—**3(1):**159
Apiaceae—**3(2):**661
Apocynaceae—**3(1):**77, 461; **3(2):**541, 565
Apocynoideae (Apocynaceae)—**3(2):**541, 565
Appunia **longipedunculata**—**3(2):**799, 809
Appunia **peduncularis**—**3(2):**799, 809
Aquatic plants—**3(2):**855
Araliaceae—**3(1):**117; **3(2):**605
Arceuthobium
  microcarpum subsp. **aristatae**—**3(1):**13, 14
  monticola—**3(2):**741
  siskiyouense—**3(2):**741
Arctic-montane buttercup—**3(1):**245
Arctostaphylos—**3(2):**673
  glandulosa—**3(2):**673
  manzanita—**3(2):**673
  patula—**3(2):**673
  pungens—**3(2):**673
  tomentosa—**3(2):**673
  uva-ursi—**3(2):**673
Argentina—**3(2):**793
Arizona, USA—**3(1):**13
Arkansas, USA—**3(1):**319; **3(2):**485
Artemisia
  bakeri—**3(2):**667
  carruthii—**3(2):**667
  coloradensis—**3(2):**667
  kansana—**3(2):**667
  pringlei—**3(2):**667
  wrightii—**3(2):**667
Asclepiadaceae—**3(2):**815
Asclepiadoideae (Apocynaceae)—**3(1):**77, 461
Asia—**3(1):**147, 245; **3(2):**815, 823
Aspleniaceae—**3(1):**307
Asteraceae—**3(1):**139, 161, 177, 231; **3(2):**573, 667, 869
Astereae (Asteraceae)—**3(1):**139, 161, 231
Astragalus
  sect. Diphysi—**3(1):**211
  diphysus var. albiflorus—**3(1):**211, 214
  lentiginosus—**3(1):**211, 213
    var. albiflorus—**3(1):**211
    var. **bryantii**—**3(1):**211, 215
    var. diphysus—**3(1):**211, 214
    var. **iodanthus**—**3(1):**211, 215
    var. micans—**3(1):**211, 216
    var. oropedii—**3(1):**211, 216
    var. **pseudiodanthus**—**3(1):**211, 216
Astrophytum—**3(1):**251
  subg. Astrophytum—**3(1):**251
  sect. Austrastrophytum—**3(1):**251
  subg. Euastrophytum—**3(1):**251
  subg. Neoastrophytum—**3(1):**251
  sect. Septentriastrophytum—**3(1):**251
  subg. Stigmatodactylus—**3(1):**251
Athenaea cernua—**3(1):**71
Azolla pinnata subsp. asiatica—**3(1):**331

Baccharis—**3(1):**139
  altimontana—**3(1):**139, 140
  sect. Caulopterae—**3(1):**139
  friburgensis—**3(1):**139, 143
  genistelloides complex—**3(1):**139
  macrophylla—**3(1):**139
  sect. Oblongifoliae—**3(1):**139
Bandelier National Monument, USA—**3(2):**921
Basidiomycota—**3(1):**257
Bauhinia
  subg. Bauhinia sect. Pauletia ser. Ariaria—**3(2):**629
  conceptionis—**3(2):**630
  eilertsii—**3(2):**630
  esmeraldasensis—**3(2):**629, 631
  flagelliflora—**3(2):**633
  flexuosa—**3(2):**620
  lilacina—**3(2):**619, 621
  maximiliani—**3(2):**621
  microstachya—**3(2):**623
  multinervia—**3(2):**633
  subg. Phanera sect. Schnella—**3(2):**619, 620
  pichinchensis—**3(2):**635
  poiteauana—**3(2):**625
  radiata—**3(2):**625
  smilacina—**3(2):**626
  tarapotensis—**3(2):**635
  trichosepala—**3(2):**619, 627
Beautempsia—**3(2):**683, 685
  avicenniifolia—**3(2):**683, 685
Begonia
  satrapis—**3(2):**823, 824
  scutata—**3(2):**823, 828
Begoniaceae—**3(2):**823
Belize—**3(1):**23, 31, 43
Berberidaceae—**3(2):**963
Berberis repens—**3(2):**963
Big Bend region, Texas, USA—**3(1):**407

Big Thicket National Preserve, USA—**3(1):**443
Big Thicket, Texas, USA—**3(1):**401
Biological invasions—**3(1):**323
Blue spruce—**3(1):**13
Boraginaceae—**3(1):**465
Bouteloua curtipendula
  varieties—**3(2):**965
  var. tenuis—**3(2):**965, 966
Brassicaceae—**3(1):**169, 227
Brazil—**3(1):**139; **3(2):**619, 659
Bristlecone pine—**3(1):**13
Bromeliaceae—**3(1):**113
Buffalo Gap National Grassland, USA—**3(1):**391

Cactaceae—**3(1):**251
Caesalpinioideae (Fabaceae)—**3(2):**619, 629
California, USA—**3(1):**323; **3(2):**479, 639, 673, 741, 855
Calyptranthes
  compactiflora—**3(1):**123
  fusca—**3(1):**123, 125
  sparsiflora—**3(1):**123, 125
Camas Prairie, Idaho, USA—**3(1):**231
Capparaceae—**3(2):**683
Capparis
  avicenniifolia—**3(2):**683
  ovalifolia—**3(2):**683
Capsicophysalis—**3(1):**71, 72
  potosina—**3(1):**71, 72
Cardamine flexuosa—**3(1):**227
Carson National Forest, USA—**3(2):**921
Caryophyllaceae/Alsinaceae—**3(2):** 501, 867
Castilleja
  angustifolia var. dubia—**3(1):**391
  chromosa—**3(1):**391
Central America—**3(1):**23, 31, 43, 71, 117; **3(2):**535
Cercideae (Caesalpinioideae: Fabaceae)—**3(2):**619, 629
Ceropegia
  hookeri—**3(2):**815, 816
  lucida—**3(2):**815, 819
Chamaesaracha—**3(1):**71
  potosina—**3(1):**71
Chihuahua, Mexico—**3(2):**527
Chloridoideae (Poaceae:)—**3(2):**527
Chloroplast sequence data—**3(1):**169
Chromolaena **clematitis**—**3(2):**573
Chromosome counts/numbers—**3(1):** 279
Circumscription—**3(2):**645
Clark, Howard L.—**3(2):**996
Coastal dry forests—**3(2):**683
Colombia—**3(2):**565
Colorado, USA—**3(1):**317; **3(2):**867
Compositae: Eupatorieae—**3(2):**573
Conata Basin, South Dakota, USA—**3(2):** 901
Corolla morphology—**3(1):**133
Costa Rica—**3(1):**85, 113, 117; **3(2):**535
Cracca
  floridana—**3(1):**157
  intermedia—**3(1):**157
Crataegus—**3(1):**239
  acutiloba—**3(1):**239
  ser. **Altaicae**—**3(1):**239, 243
  brainerdii—**3(1):**239
  brumalis—**3(1):**239
  brunetiana—**3(1):**239
  chrysocarpa var. **subrotundifolia**—**3(1):**239, 240
  demissa—**3(1):**239
  fernaldii—**3(1):**239
  gravis—**3(1):**239
  laurentiana—**3(1):**239
    var. dissimilifolia—**3(1):**239
  macrosperma—**3(1):**239
  matura—**3(1):**239
  opaca—**3(1):**331
  pastorum—**3(1):**239
  pentandra—**3(1):**239
  populnea—**3(1):**239
  roanensis—**3(1):**239
  subrotundifolia—**3(1):**239
Creeping sideoats grama—**3(2):**965
Critically endangered—**3(2):**521
Crotalaria—**3(1):**219
  maritima—**3(1):**219, 224
  rotundifolia—**3(1):**219, 222
Cryptostegia
  grandiflora—**3(1):**461
  madagascariensis—**3(1):**462
Cycadales—**3(1):**23, 31, 43
Cynodonteae (Poaceae)—**3(2):**527, 965
Cyperaceae—**3(1):**457; **3(2):**793, 831
Cyperus
  bipartitus—**3(1):**331
  eragrostis—**3(1):**331
  pilosus—**3(1):**457
Cystopteris reevesiana—**3(1):**307

Digitostigma—**3(1):**251
  caput-medusae—**3(1):**251
Dilkea—**3(2):**593
  cuneata—**3(2):**593, 595
  lecta—**3(2):**593, 597
  ovalis—**3(2):**593, 599
  subg. **Epkia**—**3(2):**593, 594
  tillettii—**3(2):**593, 599
  vanessae—**3(2):**593, 602
Diospyros—**3(1):**85
  campechiana—**3(1):**85, 89
  campechiana complex—**3(1):**85
  camposii—**3(1):**85, 93
  crotalaria—**3(1):**85, 95
  haberi—**3(1):**85, 98
  hartmanniana—**3(1):**101
  indica—**3(1):**147
  juruensis—**3(1):**104
  panamense—**3(1):**106
Dirca—**3(2):**485
  decipiens—**3(2):**485, 494
  mexicana—**3(2):**485, 496
  occidentalis—**3(2):**485, 496
  palustris—**3(2):**485, 497
Dwarf mistletoe—**3(1):**13

Ebenaceae—**3(1):**85
Echiteae (Apocynaceae, Apocynoideae)—**3(2):**541
Echites—**3(2):**541
  biflorus—**3(2):**541
  ehrenbergii—**3(2):**541
  madidus—**3(2):**541
Ecological impact—**3(2):**971
Ecuador—**3(1):**123; **3(2):**503, 511, 609, 629, 683
Education—**3(1):**1
Eleocharis wolfii—**3(2):**831
Endangered—**3(2):**815
Endemic—**3(2):**485, 639, 823
Engelmann spruce—**3(1):**13
Epidermal anatomy—**3(1):**285
Episcieae (Gesneriaceae)—**3(1):**133; **3(2):**583
Epitype—**3(1):**211
Ericaceae—**3(1):**147; **3(2):**673
Erigeron bellioides—**3(2):**869
Eriogonoideae (Polygonaceae)— **3(2):** 479
Eriogonum
  alpinum—**3(2):**639
  cedrorum—**3(2):**479
  nervulosum—**3(2):**479
  subg. Oligogonum—**3(2):**639
  villosissimum—**3(2):**639
Eugenia
  aequatoriensis—**3(2):**609
  castaneiflora—**3(2):**609, 611
  crassimarginata—**3(2):**609, 611
  longisepala—**3(2):**609, 614
  pusilliflora—**3(2):**609, 616
Eupatorieae (Asteraceae)—**3(2):**573
Eupatorium clematitis—**3(2):**573
Euphorbia extipulata—**3(1):**317
Eurybia
  aberrans—**3(1):**161, 166
  glauca—**3(1):**161
  sect. Herrickia—**3(1):**161
  sect. Horrida—**3(1):**161

    horrida—**3(1):**161
    kingii—**3(1):**161, 166
        var. **barnebyana**—**3(1):**161, 166
    pulchra—**3(1):**161
    wasatchensis—**3(1):**161

Fabaceae—**3(1):**151, 157, 211, 219, 323; **3(2):**619, 629, 751
Festuca—**3(1):**51
    aloha—**3(1):**51
    molokaiensis—**3(1):**51, 54
Flora Londonensis—**3(1):**227
Florida, USA—**3(1):**331, 339; **3(2):**869, 873
Floristic diversity—**3(2):**921
Forest
    upland shortleaf pine/oak-hickory—**3(1):**367
    upland shortleaf pine—**3(1):**367
Formosa firethorn—**3(1):**319
French Guiana—**3(2):**577

Galapagos Islands—**3(1):**177
Generation time—**3(2):**673
Geographic range shift—**3(2):**815
Geranium maculatum—**3(1):**331
Gesneriaceae—**3(1):**133; **3(2):**583
Ghana—**3(1):**309
Glyceria declinata—**3(1):**393
Gonolobinae (Apocynaceae, Asclepiadoideae) —**3(1):**77
Gonolobus—**3(1):**77
    rostratus—**3(1):**77, 78
    tobagensis—**3(1):**77, 82
Grasslands—**3(1):**323
Guatemala—**3(1):**71
Guiana Shield, Checklist of the Plants of the—**3(2):**799
Guiana Shield—**3(1):**133; **3(2):**581
Guianas—**3(2):**593
Guinea savanna—**3(1):**309
Gulf of Mexico—**3(2):**873
Guzmania
    blasii—**3(1):**113
    mitis—**3(1):**113
Gylceria
    arkansana—**3(1):**393
    septentrionalis—**3(1):**393
    striata—**3(1):**393

Habitat degradation/loss—**3(2):**815, 823
Hawaii, USA—**3(1):**51
Hedyotideae (Rubiaceae)—**3(2):**521
Hedyotis—**3(1):**59
    galeottii—**3(1):**59
    kingii—**3(1):**59
    latifolia—**3(1):**59
    terrellii—**3(1):**59
Heliantheae (Asteraceae)—**3(1):**177
Herrickia horrida—**3(1):**161
Honduras—**3(1):**113
Hygrocybe
    chamaeleon—**3(1):**257, 264
    mississippiensis—**3(1):**257, 264

Idaho, USA—**3(1):**231
India—**3(1):**147; **3(2):**815, 823
Interspecific hybridization—**3(2):**673
Invasive species—**3(1):** 323; **3(2):**901
Invasiveness Index—**3(2):**971
Isonym—**3(2):**661
IUCN Red List—**3(2):**521

Jemez Mountains, USA—**3(2):**921

Kansas, USA—**3(2):**485
Kendrick Peak, Arizona, USA—**3(1):**13
Kew, The Royal Botanic Gardens—**3(2):**763

Lamiaceae—**3(1):**383
Lamium purpureum—**3(1):**331
Leaf epidermis—**3(1):**285
Lectotype—**3(1):**43, 211, 227
Lesser celandine—**3(1):**193
Lewis and Clark—**3(2):**763
Liberal arts—**3(1):**1
Lipocarpha micrantha—**3(2):**793, 794
Lolinnae (Poaceae)—**3(1):**51
Louisiana, USA—**3(1):**349, 355, 367, 375, 379

Machaerantherinae (Asteraceae)—**3(1):**161
Mandevilla—**3(2):**565
    albifolia—**3(2):**565
    caquetana—**3(2):**565, 567
    sanctae-martae—**3(2):**565, 569
Marcgraviaceae—**3(2):**691
Marco Island (Florida)—**3(2):**873
Maryland, USA—**3(2):**905
Maya Mountains, Belize—**3(1):**31, 43
Medic—**3(1):**323
Medicago
    rigidula—**3(1):**323
    truncatula—**3(1):**323
Melanthiaceae—**3(1):**159
Meliosma—**3(2):**535
    hartshornii—**3(2):**535
    irazuensis—**3(2):**535, 537
    isthmensis—**3(2):**535, 537
Melochia nodiflora—**3(1):**331
Memoriam—**3(2):**995, 996
Mentha
    longifolia—**3(1):**383
    ×rotundifolia—**3(1):**383
    suaveolens—**3(1):**383
Mesechiteae (Apocynaceae, Apocynoideae)—**3(2):**565
Mesoamerica—**3(1):**85, 113
Mexico—**3(1):**59, 71, 85, 285, 307; **3(2):** 521, 527, 751, 771, 775
Mexotis—**3(1):**59, 60
    galeottii—**3(1):**59, 61
    kingii—**3(1):**59, 64
    latifolia—**3(1):**59, 61
    lorencei—**3(1):**59, 67
    terrellii—**3(1):**59, 64
Michaux names—**3(2):**739
Micromorphology, fruit—**3(2):**793
Molecular phylogeny—**3(2):**673
Moloka'i, Hawaii, USA—**3(1):**51
Morphology—**3(2):**741, 793
Morse Clay prairie—**3(1):**355
Muhlenbergia—**3(1):**285; **3(2):**527
    subg. Muhlenbergia—**3(1):**285; **3(2):**527
    tarahumara—**3(2):**527, 528
    subg. Trichochloa—**3(1):**285
Mycology—**3(1):**257
Myrcia
    aequatoriensis—**3(1):**123, 128
    verticillata—**3(1):**123, 130
Myrtaceae—**3(1):**123; **3(2):**609

Naturalized—**3(2):**901
Neotropics—**3(2):**541, 565, 573
Neotype/neotypification—**3(1):**219; **3(2):**667
New Mexico, USA—**3(1):**317; **3(2):**921
Nicaragua—**3(1):**117
Nonnative plants—**3(1):**323, 461; **3(2):** 855, 971
North America—**3(1):**3, 13, 59, 151, 157, 169, 193, 211, 219, 231, 239, 245, 251, 257, 285, 307, 317, 319, 323, 331, 339, 349, 355, 367, 375, 379, 383, 391, 393, 395, 401, 407, 443, 457, 461, 465; **3(2):**469, 479, 485, 521, 639, 727, 739, 741, 751, 771, 775, 831, 855, 867, 869, 873, 901, 905, 921, 963, 965, 969, 971
North Carolina, USA—**3(1):**151, 383
Nuclear ribosomal ITS—**3(2):**673
Nuclear sequence data—**3(1):**169
Nuevo León, Mexico—**3(2):**771

Ochna serrulata—**3(1):**331
Oregon, USA—**3(1):**231; **3(2):**639, 741
Oreopanax
    geminatus—**3(1):**117
    nicaraguensis—**3(1):**117
    nubigenus—**3(1):**117

  paramicolus—3(1):117, 118
  peltatus—**3(1):**117
Orobanchaceae—**3(1):**3
Orobanche
  ludoviciana—**3(1):**3
  sect. Nothaphyllon—**3(1):**3
  riparia—3(1):3, 7
Oxalidaceae—**3(2):**727
Oxalis—**3(2):**727
  corniculata—**3(2):**729
  sect. Corniculatae—**3(2):**727
  dillenii—**3(2):**727, 730
    subsp. filipes—**3(2):**727
  florida—**3(2):**727, 733
  grandis—**3(2):**727, 736
  illinoensis—**3(2):**727, 736
  lyonii—**3(2):**727
  priceae—**3(2):**727, 731
    subsp. texana—**3(2):**727
  stricta—**3(2):**727, 734
  texana—**3(2):**727, 732
Oxypolis
  denticulata—**3(2):**661
  rigidior—**3(2):**661, 662
  ternata—**3(2):**661, 662

Palouse grasslands, Washington, USA—**3(1):**231
Panama—**3(1):**113, 117; **3(2):**535
Pappobolus—**3(1):**177
Paradrymonia
  glandulosa—3(2):583
  hamata—3(2):583, 585
  lutea—3(2):583, 585
  maculata—**3(1):**133
  maguirei—3(1):133, 134
  subg. **Pagothyra—3(1):**134
  subg. Paradrymonia—**3(2):**583
  tepui—3(2):583, 588
  yatua—3(2):583, 588
Parfitt, Bruce Dale—**3(2):**995
Passiflora—**3(1):**331; **3(2):**577, 581, 593
  supersect. Coccinea—**3(2):**581
  compar—**3(2):**581
  curva—3(2):577
  longicuspis—**3(2):**581
  subg. Passiflora supersect. Coccinea—**3(2):**577
  tecta—**3(2):**581, 582
  vitifolia—**3(1):**331
Passifloraceae—**3(2):**577, 581, 593
Pennsylvania, USA—**3(2):**963
Peru—**3(2):**683
Peucedanum ternatum—**3(2):**661
Phaseolus
  marechalii—**3(2):**751
  sect. Paniculati—**3(2):**751
  rotundatus—**3(2):**751
Phlox—**3(2):**645
  austromontana
    subsp. **jonesii—3(2):**645
    subsp. **lutescens—3(2):**645, 646
  caespitosa—**3(2):**645
  condensata subsp. **covillei—3(2):**645, 646
  douglasii—**3(2):**645
  missoulensis—**3(2):**645
  pilosa subsp. **longipilosa—3(2):**645, 647
  richardsonii—**3(2):**645
    subsp. **borealis—3(2):**645, 647
  subulata subsp. **setacea—3(2):**645, 649
  villosissima subsp. **latisepala—3(2):**645, 649
Phylogeny—**3(2):**485
Physaleae (Solanaceae)—**3(1):**71
Physalineae (Physaleae: Solanaceae)—**3(1):**71
Physalis—**3(1):**71
Picea
  engelmannii—**3(1):**13
  pungens—**3(1):**13
Pinaceae—**3(2):**771
Pinus
  aristata—**3(1):**13
  attenuata—**3(2):**741
  contorta var. contorta—**3(2):**741
  jeffreyi—**3(2):**741
  monticola—**3(2):**741
  pinceana—**3(2):**771
Poa secunda—**3(2):**763
Poaceae—**3(1):**51, 285, 393; **3(2):**527, 763, 775, 905, 965
Polemoniaceae—**3(2):**645
Polygala cymosa—**3(2):**969
Polygalaceae—**3(2):**969
Polygonaceae—**3(2):**479, 639
Polyploidy—**3(2):**673
Principle components analysis—**3(1):**231
Priority—**3(1):**43
Pyracantha koidzumii—**3(1):**319
Pyrrocoma
  liatriformis—**3(1):**231
  scaberula—**3(1):**231

Ranunculaceae—**3(1):**193, 245
Ranunculus
  sect. Auricomus—**3(1):**245
  sect. Epirotes—**3(1):**245
  ficaria—**3(1):**193
    subsp. bulbilifer—**3(1):**195
    subsp. calthifolius—**3(1):**195
    subsp. chrysocephalus—**3(1):**195
    subsp. ficaria—**3(1):**195
    subsp. ficariiformis—**3(1):**195
  gelidus—**3(1):**245
  grayi—**3(1):**245
  karelinii—**3(1):**245
Rare—**3(2):**823
Rhabdadenia—**3(2):**541, 547
  biflora—**3(2):**541, 548
  lindeniana—**3(2):**541
  macrostoma—**3(2):**541, 552
  madida—**3(2):**541, 552
  pohlii—**3(2):**541
    var. suberecta—**3(2):**541
  ragonesei—**3(2):**541, 557
Rio de Janeiro, Brazil—**3(1):**139
Rocky Mountains, USA—**3(1):**317
Rosaceae—**3(1):**239, 319
Rubiaceae—**3(1):**59; **3(2):**521, 799

Sabiaceae—**3(2):**535
Sagina caespitosa—**3(2):**867
Saline prairie—**3(1):**349
Salvinia
  auriculata complex—**3(2):**855
  minima—**3(2):**855
  molesta—**3(2):**855
  oblongifolia—**3(2):**855
Salviniaceae—**3(2):**855
San Francisco Peaks, Arizona, USA—**3(1):**13
San Luis Potosi, Mexico—**3(1):**71
Sangre de Cristo Range, USA—**3(2):**921
Santa Fe National Forest, USA—**3(2):**921
Scalesia—**3(1):**177
Schefflera
  pittieri—**3(2):**605
  quinquestylorum—**3(2):**605
  vanderwerffii—3(2):605
Schwartzia—**3(2):**691, 694
  adamantium—**3(2):**696
  andina—**3(2):**698
  antioquensis—**3(2):**700
  brasiliensis—**3(2):**702
  chocoensis—**3(2):**704
  geniculatiflora—**3(2):**706
  jucuensis—**3(2):**708
  lozaniana—**3(2):**710
  magnifica—**3(2):**712
  Norantea complex—**3(2):**691
  parrae—**3(2):**712
  pterosara—**3(2):**715

    renvoizei—**3(2):**717
    spiciflora—**3(2):**719
    weddelliana—**3(2):**719
Scrophulariaceae—**3(1):**391
Selenia—**3(1):**169
    grandis—**3(1):**169
    mexicana—**3(1):**169
Sida urens—**3(1):**331
Sikkim Himalaya—**3(2):**815, 823
Simsia—**3(1):**177
Singsaglebini Forest Reserve, Ghana—**3(1):**309
Sium denticulatum—**3(2):**661
Snake River Canyons, Idaho, USA—**3(1):**231
Solanaceae—**3(1):**71; **3(2):**503, 511
Solanum—**3(2):**503, 511
    circinatum subsp. **ramosum**—**3(2):**509
    corymbiflorum subsp. mortonianum—**3(2):**509
    crassinervium—**3(2):**511, 514
    dalibardiforme—**3(2):**511
    deflexum—**3(2):**503
    diversifolium subsp. **chloranthum**—**3(2):**509
    dolichorhachis—**3(2):**511
    endopogon subsp. **guianense**—**3(2):**509
    evolvulifolium—**3(2):**511
    sect. Gonatotrichum—**3(2):**503
    sect. Herpystichum—**3(2):**511
    hoffmanseggii—**3(2):**503
    huilense—**3(2):**509
    limoncochaense—**3(2):**511, 516
    manabiense—**3(2):**503, 504
    obliquum—**3(2):**503
    pacificum—**3(2):**511, 512
    sect. Pachyphylla—**3(2):**503
    turneroides—**3(2):**503
    zumbense—**3(2):**503, 506
Sonora, Mexico—**3(2):**521
South America—**3(1):**77, 85, 123, 133, 139; **3(2):**503, 511, 565, 573, 577, 581, 583, 593, 605, 609, 629, 659, 683, 691, 793, 799
South Carolina, USA—**3(1):**151
South Dakota, USA—**3(1):**391; **3(2):**901
Species richness—**3(1):**401
Spermacoceae (Hedyotideae, Rubiaceae)—**3(2):**521
Sphaeropteris cooperi—**3(1):**331
Stenaria—**3(2):**521
    sanchezii—**3(2):**521, 522
Superimposed nucleotide additivity patterns—**3(2):**673
Symplocaceae—**3(2):**659
Symplocos
    itatiaiae var. pentandra—**3(2):**659
    pentandra—**3(2):**659, 660
Synthesis of the North America Flora—**3(1):**407

Tephrosia
    chrysophylla—**3(1):**157
    florida—**3(1):**157
    ×floridana—**3(1):**157
    ×intermedia—**3(1):**157
Texas, USA—**3(1):**257, 393, 395, 401, 407, 443, 457, 461, 465; **3(2):**965, 969, 971
Three-letter family acronyms—**3(1):**273; **3(2):**993
Thymelaea passerina —**3(2):**901
Thymelaeaceae—**3(2):**485, 901
Tillandsoideae (Bromeliaceae)—**3(1):**113
Torilis arvensis—**3(1):**331
Tournefortia hirsutissima—**3(1):**465
Trans-Pecos Vegetational Area, Texas, USA—**3(1):**407
Trichostigma octandrum—**3(2):**873
Trifolium dasyphyllum var. anemophilum—**3(1):**317
Trinidad and Tobago—**3(1):**77
Triniteurybia—**3(1):**161
Tryphane—**3(2):**501
    rubella—**3(2):**501
        subsp. **propinqua**—**3(2):**501, 502
Tusas Mountains, USA—**3(2):**921
Typifications—**3(1):**43, 211, 219, 227, 239; **3(2):**667, 739

USA—**3(1):**3, 13, 51, 151, 193, 219, 257, 319, 323, 331, 339, 349, 355, 367, 375, 379, 383, 391, 393, 395, 401, 407, 443, 457, 461, 465; **3(2):**469, 479, 485, 639, 741, 831, 867, 869, 873, 901, 905, 921, 963, 965, 969, 971
Valles Caldera National Preserve, USA—**3(2):**921
Vascular flora—**3(2):**873
Vegetational areas—**3(1):**395
Venezuela—**3(1):**133; **3(2):**565, 583, 605
Viguiera—**3(1):**177
Viscaceae—**3(1):**13; **3(2):**741
Vitaceae—**3(2):**739
Vitis
    aestivalis—**3(2):**739
    cordifolia—**3(2):**739
    riparia—**3(2):**739
    rotundifolia—**3(2):**739

Washington, USA—**3(1):**231
Werauhia
    brunei—**3(1):**113
    camptoclada—**3(1):**113
    luctuosa—**3(1):**113, 114
    pittieri—**3(1):**113
West Gulf Coastal Plain, USA—**3(1):**349, 367
Wetlands—**3(2):**855
Wildland-urban interface—**3(2):**855
Wolf's spike-rush—**3(2):**831
Woody plants—**3(1):**309

Xanthoxalis—**3(2):**727
Xyridaceae—**3(2):**469
Xyris
    spathifolia—**3(2):**469, 472
    tennesseensis—**3(2):**469

Zacatecas, Mexico—**3(2):**775
Zamia
    bussellii/onan-reyesii—**3(1):**31
    cremnophila—**3(1):**23
    decumbens—**3(1):**31
    furfuracea—**3(1):**23
    meermanii—**3(1):**23
    monticola—**3(1):**31
    polymorpha—**3(1):**43
    prasina—**3(1):**43, 44
    sandovalii—**3(1):**23
    tuerckheimii—**3(1):**31
Zamiaceae—**3(1):**23, 31, 43
Zigadenus elegans var. glaucus—**3(1):**159

95 New Names and New Combinations:

Volume 3 (2009)

Amorpha confusa (Wilbur) S.C.K. Straub, Sorrie & Weakley, comb. et stat. nov.—**3(1):**154
Anticlea elegans var. **glaucus** (Nutt.) Zomlefer & Judd, comb. nov.—**3(1):**159
Appunia longipedunculata (Steyerm.) Delprete, comb. nov.—**3(2):**809
Appunia peduncularis (Kunth) Delprete, comb. nov.—**3(2):**809
Arceuthobium microcarpum subsp. **aristatae** J.M. Scott & Mathiasen, subsp. nov.—**3(1):**14
Astragalus lentiginosus var. **bryantii** (Barneby) J.A. Alexander, comb. nov.—**3(1):**215
Astragalus lentiginosus var. **iodanthus** (S. Watson) J.A. Alexander, comb. nov.—**3(1):**215
Astragalus lentiginosus var. **pseudiodanthus** (Barneby) J.A. Alexander, comb. nov.—**3(1):**216
Baccharis altimontana Heiden, Baumgratz & Esteves, sp. nov.—**3(1):**140
Baccharis friburgensis Heiden, Baumgratz & Esteves, sp. nov.—**3(1):**143
Bauhinia esmeraldasensis Wunderlin, sp. nov.—**3(2):**631
Bauhinia lilacina Wunderlin & Eilers, sp. nov.—**3(2):**621
Bauhinia trichosepela (L.P. Queiroz) Wunderlin & Eilers, comb. nov.—**3(2):**627
Calyptranthes compactiflora M.L. Kawasaki & B.K. Holst, sp. nov.—**3(1):**123
Calyptranthes fusca M.L. Kawasaki & B.K. Holst, sp. nov.—**3(1):**125
Calyptranthes sparsiflora M.L. Kawasaki & B.K. Holst, sp. nov.—**3(1):**125
Capsicophysalis (Bitter) Averett & M. Martínez, stat. nov.—**3(1):**72
Capsicophysalis potosina (B.L. Rob. & Greenm.) Averett & M. Martínez, comb. nov.—**3(1):**72
Chromolaena clematitis (DC.) Pruski, comb. nov.—**3(2):**573
Crataegus series **Altaicae** J.B. Phipps, ser. nov.—**3(1):**243
Crataegus chrysocarpa var. **subrotundifolia** (Sarg.) J.B. Phipps, comb. et stat. nov.—**3(1):**240
Dilkea cuneata Feuillet, sp. nov.—**3(2):**595
Dilkea subg. **Epkia** Feuillet, subg. nov.—**3(2):**594
Dilkea lecta Feuillet, sp. nov.—**3(2):**597
Dilkea ovalis Feuillet, sp. nov.—**3(2):**599
Dilkea tillettii Feuillet, sp. nov.—**3(2):**599
Dilkea vanessae Feuillet, sp. nov.—**3(2):**602
Diospyros camposii M.C. Provance & A.C. Sanders, sp. nov.—**3(1):**93
Diospyros crotalaria M.C. Provance & A.C. Sanders, sp. nov.—**3(1):**95
Diospyros haberi M.C. Provance & A.C. Sanders, sp. nov.—**3(1):**98
Diplycosia indica M.R. Debta & H.J. Chowdhery, sp. nov.—**3(1):**147
Dirca decipiens A. Floden, sp. nov.—**3(2):**494
Eriogonum cedrorum Reveal & Raiche, sp. nov.—**3(2):**479
Eriogonum villosissimum Reveal & D.A. York, sp. nov.—**3(2):**639
Eugenia aequatoriensis M.L. Kawasaki & B.K. Holst, sp. nov.—**3(2):**609
Eugenia castaneiflora M.L. Kawasaki & B.K. Holst, sp. nov.—**3(2):**611
Eugenia crassimarginata M.L. Kawasaki & B.K. Holst, sp. nov.—**3(2):**611
Eugenia longisepala M.L. Kawasaki & B.K. Holst, sp. nov.—**3(2):**614
Eugenia pusilliflora M.L. Kawasaki & B.K. Holst, sp. nov.—**3(2):**616
Eurybia aberrans (A. Nels.) G.L. Nesom, comb. nov.—**3(1):**166
Eurybia kingii (D.C. Eaton) G.L. Nesom, comb. nov.—**3(1):**166
Eurybia kingii var. **barnebyana** (Welsh & Goodrich) G.L. Nesom, comb. nov.—**3(1):**166
Festuca aloha Catalán, Soreng & P.M. Peterson, sp. nov.—**3(1):**51
Festuca molokaiensis Soreng, P.M. Peterson & Catalán, sp. nov.—**3(1):**54
Hygrocybe chamaeleon (Cibula) Lewis & Ovrebo, comb. nov.—**3(1):**264
Hygrocybe mississippiensis (Cibula) Lewis & Ovrebo, comb. nov.—**3(1):**264
Mandevilla albifolia J.F. Morales, sp. nov.—**3(2):**565
Mandevilla caquetana J.F. Morales, sp. nov.—**3(2):**567
Mandevilla sancta-martae J.F. Morales, sp. nov.—**3(2):**569
Meliosma isthmensis J.F. Morales, sp. nov.—**3(2):**537
Mexotis Terrell & H. Rob., gen. nov.—**3(1):**60
Mexotis galeottii (M. Martens) Terrell & H. Rob., comb. nov.—**3(1):**61
Mexotis kingii (Terrell) Terrell & H. Rob., comb. nov.—**3(1):**64
Mexotis latifolia (M. Martens & Galeotti) Terrell & H. Rob., comb. nov.—**3(1):**61
Mexotis lorencei Terrell & H. Rob., sp. nov.—**3(1):**67
Mexotis terrellii (Lorence) Terrell & H. Rob., comb. nov.—**3(1):**64
Muhlenbergia tarahumara P.M. Peterson & Columbus, sp. nov.—**3(2):**528
Myrcia aequatoriensis M.L. Kawasaki & B.K. Holst, sp. nov.—**3(1):**128
Myrcia verticillata M.L. Kawasaki & B.K. Holst, sp. nov.—**3(1):**130
Oreopanax paramicolus J.F. Morales & A. Idárraga, sp. nov.—**3(1):**118
Orobanche riparia L.T. Collins, sp. nov.—**3(1):**7
Paradrymonia glandulosa Feuillet, sp. nov.—**3(2):**583
Paradrymonia hamata Feuillet, sp. nov.—**3(2):**585
Paradrymonia lutea Feuillet, sp. nov.—**3(2):**585
Paradrymonia maguirei Feuillet, sp. nov.—**3(1):**134
Paradrymonia subg. **Pagothyra** (Leeuwenb.) Feuillet, comb. et stat. nov.—**3(1):**134
Paradrymonia tepui Feuillet, sp. nov.—**3(2):**588
Paradrymonia yatua Feuillet, sp. nov.—**3(2):**588
Passiflora curva Feuillet, sp. nov.—**3(2):**577
Phlox austromontana subsp. **jonesii** (Wherry) Locklear, comb. et stat. nov.—**3(2):**645

Phlox austromontana subsp. **lutescens** (S.L. Welsh) Locklear, comb. et stat. nov.—**3(2):**646
Phlox condensata subsp. **covillei** (E.E. Nelson) Locklear, comb. et stat. nov.—**3(2):**646
Phlox pilosa subsp. **longipilosa** (Waterf.) Locklear, comb. et stat. nov.—**3(2):**647
Phlox richardsonii subsp. **borealis** (Wherry) Locklear, comb. nov.—**3(2):**647
Phlox subulata subsp. **setacea** (L.) Locklear, comb. et stat. nov.—**3(2):**649
Phlox villosissima subsp. **latisepala** (Wherry) Locklear, comb. nov.—**3(2):**649
Schefflera vanderwerffii Dorr & Stergios, sp. nov.—**3(2):**605
Solanum circinatum subsp. **ramosum** (Bohs) Bohs, comb. nov.—**3(2):**509
Solanum crassinervium Tepe. sp. nov.—**3(2):**514
Solanum diversifolium subsp. **chloranthum** (Rusby) Bohs, comb. nov.—**3(2):**509
Solanum endopogon subsp. **guianense** (Bohs) Bohs, comb. nov.—**3(2):**509
Solanum huilense Bohs, nom. nov.—**3(2):**509
Solanum limoncochaense Tepe, sp. nov.—**3(2):**516
Solanum manabiense S. Stern, sp. nov.—**3(2):**504
Solanum pacificum Tepe, sp. nov.—**3(2):**512
Solanum zumbense Bohs, sp. nov.—**3(2):**506
Stenaria sanchezii Lorence, sp. nov.—**3(2):**522
Symplocos pentandra (Mattos) Occhioni ex Aranha, comb. et stat. nov.—**3(2):**660
Tephrosia ×intermedia (Small) G.L. Nesom & Zarucchi, comb. nov.—**3(1):**157
Tryphane rubella (Wahlenb.) A. & D. Löve ex W.A. Weber, comb. nov.—**3(2):**501
Tryphane rubella subsp. **propinqua** (Richardson) A. & D. Love ex W.A. Weber, comb. nov.—**3(2):**502
Werauhia luctuosa J.F. Morales, sp. nov.—**3(1):**114
Xyris spathifolia Kral & Moffett, sp. nov.—**3(2):**472
Zamia decumbens Calonje, Meerman, M.P. Griff. & Hoese, sp. nov.—**3(1):**31
Zamia meermanii Calonje, sp. nov.—**3(1):**23

AVAILABLE TITLES FROM THE BRIT PRESS

SBM 01 | A Quantitative Analysis of the Vegetation on the Dallas County White Rock Escarpment
SBM 02 | The Vascular Flora of St. Francis County, Arkansas
SBM 04 | Asteraceae of Louisiana
SBM 05 | The Genus *Mikania* (Compositae: Eupatorieae) in México
SBM 06 | Frontier Botanist William Starling Sullivant's Flowering-Plant Botany of Ohio
SBM 07 | A Taxonomic Revision of the Acaulescent Blue Violets (*Viola*) of North America
SBM 08 | *Aster* & *Brachyactis* (Asteraceae) in Oklahoma
SBM 09 | The Genus *Mikania* (Compositae: Eupatorieae) in the Greater Antilles
SBM 10 | Checklist of the Vascular Plants of Tennessee
SBM 11 | Text Annotations & Identification Notes for Manual of the Vascular Flora of the Carolinas
SBM 12 | The "El Cielo" Biosphere Reserve, Tamaulipas, México
SBM 13 | Flora de Manantlan
SBM 14 | *Niebla* & *Vermilacinia* (Ramalinaceae) from California & Baja California
SBM 15 | Monograph of Northern Mexican *Crataegus* (Rosaceae, subfam. Maloideae)
SBM 16 | Shinners & Mahler's Illustrated Flora of North Central Texas
SBM 17 | The Grasses of Barbados (Poaceae)
SBM 18 | Floristics in the New Millenium: Proceedings of the Flora of the Southeast U.S. Symposium
SBM 19 | Emanuel D. Rudolph's Studies in the History of North American Botany
SBM 20 | Generic Conspectus of the Tribe Asterae (Asteraceae) in North & Central America
SBM 21 | A Comparative Checklist of the Plant Diversity of the Iwokrama Forest, Guyana
SBM 22 | Lloyd Herbet Shinners: By Himself
SBM 23 | Taxonomy, Distribution, & Ecology of the Genus *Phaseolus* (Leguminosae)
SBM 24 | Atlas of the Vascular Plants of Texas, Volume 1 & 2
SBM 25 | Los Géneros de Léguminosas del Norte de México
SBM 26 | Illustrated Flora of East Texas, Volume 1
SBM 27 | The Genus *Psychotria* (Rubiaceae) in the Philippine Archipelago
SBM 28 | Wild Flowers of Mombacho (Nicaragua)
SBM 29 | *Muhlenbergia* (Poaceae) de Chihuahua, México
SBM 30 | Tundra to Tropics: The Floristic Plant Geography of North America
SBM 31 | A Fifth Checklist of Tennessee Vascular Plants

OTHER PUBLICATIONS

Keys to the Vascular Plants of the Black Gap Wildlife Management Area, Brewster County

◆

Mosses of Texas: A Manual of the Moss Flora

◆

Eriocaulaceae of Continental North America, North of México

◆

Trees in the Life of the Maya World

◆

Violets (*Viola*) of Central & Eastern United States: An Introductory Survey

◆

The Ecology of our Landscape: The Botany of Where we Live

BRIT
PRESS

For more information regarding details & pricing for these publications
please visit our website at www.britpress.org

JOURNAL OF THE BOTANICAL RESEARCH INSTITUTE OF TEXAS

BRIT

The *Journal of the Botanical Research Institute of Texas*, formerly called *Sida, Contributions to Botany*, publishes research in classical and modern systematic botany—including studies of anatomy, biogeography, chemotaxonomy, ecology, evolution, floristics, genetics, paleobotany, palynology, and phylogenetic systematics. Geographic coverage is global. Articles are published in either English or Spanish; an abstract is provided in two languages. All contributions are peer reviewed and frequently illustrated with maps, line drawings, and full color photographs.

The journal is published twice yearly in a multiple topic format and provides information to scientists, professionals, and the general public for research, education, and cultural enhancement. All articles are indexed and abstracted in print and/or electronic form by the following: AGRICOLA Database (National Agricultural Library); Applied Botany Abstracts; Biosciences Information Service of Biological Sciences (BIOSIS); Current Awareness in Biological Sciences (CABS); The Kew Record of Taxonomic Literature; Natural Products Alert (NAPRALERT); and Referativnyi Zhurnal (Abstracts Journal of the Institute of Scientific Information of the Republic of Russia).

Lloyd H. Shinners, whose herbarium and library were the basis of the Southern Methodist University (SMU) legacy that became BRIT in 1987, founded the journal in 1962. **William F. Mahler** succeeded Shinners as SMU herbarium director in 1971 and inherited both ownership and editorship of the journal. Since 1993, it has been published by the Botanical Research Institute of Texas.

The current issue of the *Journal of the Botanical Research Institute of Texas* is available online at http://www.britpress.org.

ISSN 1934-5259